PERFORMANCE SPECIFICATIONS

STUDENT HOUSING
SNOW COLLEGE

HFSA # 1041.03

DFCM # 10290700

APRIL 6, 2011

HFS*Architects*

ARCHITECTURE
INTERIORS
PLANNING

ARCHITECT

HFS*Architects*
1484 South State Street
Salt Lake City, Utah 84115
(801) 596-0691
Fax (801) 596-0693

MECHANICAL ENGINEER

WHW Engineering, Inc.
8619 South Sandy Parkway #101
Sandy, Utah 84070
(801) 466-4021
FAX (801) 466-8536

ELECTRICAL ENGINEER

BNA Consulting Engineers
635 S. State Street
Salt Lake City, Utah 84111
(801) 532-2196
FAX (801) 532-2305

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SECTION 01310 - PROJECT MANAGEMENT AND COORDINATION

1.1 SUMMARY

A. Coordination Drawings.

B. Administrative and supervisory personnel.

C. Project meetings.

1.2 COORDINATION DRAWINGS

A. The contractor is responsible for coordination drawings, which may be required to coordinate the individual trades in particularly congested areas.

1.3 ADMINISTRATIVE AND SUPERVISORY PERSONNEL

A. The contractor Superintendent shall be on the project at all times work is being performed.

B. The Superintendent shall not be changed without express permission by DFCM.

1.4 PROJECT MEETINGS

A. Preconstruction conference.

B. Preinstallation Conferences: Before each construction activity that requires coordination with other construction.

C. Progress Meetings: At weekly intervals. Architect is responsible for documenting the meetings, using the DFCM standard form. Architect is also responsible for developing Prs, Proposal Requests; CCDs,Construction Change Directives; ASIs,Architects Supplemental Instructions; and COs, Change Orders. Contractor is responsible for updating the Schedule weekly, with a 3 week “Look Ahead”. Contractor is responsible for developing RFIs, Request for Information; Proposals for Change Orders; and Pay Requests. Pay Requests shall be coordinated with the weekly meeting so that they can be reviewed and approved at the meeting.

D. Coordination Meetings: The Contractor is responsible for organizing Coordination Meetings at appropriate stages of construction. If the Owner’s and/or Architect should be present, the Contractor shall schedule them.

E. Pre-Installation Meeting: The technical specifications list pre-installation meetings. The Contractor is responsible for scheduling these.

END OF SECTION 01310

SECTION 01330 - SUBMITTAL PROCEDURES

1.1 SUMMARY

A. Action Submittals: Information that requires Architect's responsive action.

B. Informational Submittals: Information that does not require Architect's approval. Submittals may be rejected for not complying with requirements.

1.2 PROCEDURES

A. Electronic copies of CAD Drawings of the Contract Documents will be provided by Architect for Contractor's use.

B. All submittals shall be submitted digitally. Each submittal shall be clearly labeled by name and specification section number reference (for example: “Glazing, Section 08800", not “Submittal 123").

C. Submittal Schedule: Submittals shall be delivered to the Architect for review in a timely manner, sufficient to allow for their review and the ordering, fabrication, delivery, installation, etc. at the jobsite.

1. The Contractor is to deliver the submittals as outlined below, from the date of the Notice to Proceed. There shall be deducted from any amount due, or that may become due the Contractor, a sum of $100.00 per day, per submittal for each and every day beyond the date listed below from the Notice to Proceed. Such sum is fixed and agreed upon by the DFCM and the Contractor as liquidated damages due the DFCM by reason of the inconvenience and added costs of administration, engineering, supervision and other costs resulting from the Contractor’s default, and not as a penalty.

   a. 60 days for Structural, Site Utilities, Masonry, Boilers, Chillers, Transformers , Switchgear and any other long lead time items.
   b. 90 days for Doors, Frames, Hardware, Windows, Storefront.
   c. 120 days for Roofing, Lighting, Mechanical Equipment, and Plumbing Fixtures.
   d. 150 days for finishes.
   e. 180 days for Landscaping and anything else that remains.

D. Processing Time:

1. Initial Review: 14 days.
2. Resubmittal Review: 14 days.
3. Sequential Review: 21days.
4. Concurrent Consultant Review: 14 days.

E. Action Submittals:

1. Number of Copies: Six. (Architect to retain 1 copy for Snow College)
2. Action Submittals:

a. Product Data.
b. Shop Drawings.
c. Samples.
d. Product schedule or list.
e. Contractor's Construction Schedule.
f. Submittals Schedule.
g. Application for Payment.
h. Schedule of Values.
i. Subcontract list.

F. Informational Submittals:

1. Number of Copies: Six (Architect to retain 1 copy for Snow College).
2. Informational Submittals:

a. Coordination Drawings.
b. Contractor's Construction Schedule.
c. Qualification data.
d. Welding certificates.
e. Installer certificates.
f. Manufacturer certificates.
g. Product certificates.
h. Material certificates.
i. Material test reports.
j. Product test reports.
k. Research/evaluation reports.
l. Schedule of tests and inspections.
m. Preconstruction test reports.
n. Compatibility test reports.
o. Field test reports.
p. Maintenance data.
q. Design data.
r. Manufacturer's instructions.
s. Manufacturer's field reports.
t. Insurance certificates and bonds.
u. Construction photographs and videotapes.
v. Material Safety Data Sheets: Submitted directly to Owner.

G. Contractor's Review:

1. Submittals: Marked with approval stamp before submitting to Architect.

H. Architect's Action:

1. Action Submittals: Stamped with an action stamp and returned.
2. Informational Submittals: Reviewed but not returned, or rejected if it does not comply with requirements.
3. Submittals Not Required: May not be reviewed and may be discarded.

END OF SECTION 01330

SECTION 01400 - QUALITY REQUIREMENTS

1.1 SUMMARY

A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies.

B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that completed construction complies with requirements.

1.2 QUALITY ASSURANCE

A. Qualifications:

1. Installer.
2. Manufacturer.
3. Fabricator.
4. Professional engineer.
5. Specialists.
6. Factory-authorized service representative.

B. Mockups: Provide mockups for each form of construction and finish required, using materials indicated for the completed Work. Mockups establish the standard by which the Work will be judged. Mockups shall include the following:

1. Exterior: Provide a mockup of a corner. Walls shall extend at least 8 feet each side of the corner and shall include windows and all exterior finishes from the foundation up to and including the soffit and roof overhang. The mockup can shorten the floor to floor heights, but each floor must be included. All finishes must be included. This mockup will serve to represent the asthetic effect as well as serve as the standard for quality for all exterior material workmanship.
2. Interior: Provide a mock up of a typical bedroom, including all finishes on all surfaces- floor, walls, ceiling. This mockup will include lighting, outlets, switches, window, built in casework, door and frame, etc. The intent is to show all components of a room and establish the standard for quality for all interior material workmanship.
3. Disposition: Exterior: Demolished and removed at the end of construction. Interior may become part of the Work.

1.3 QUALITY CONTROL

A. Owner Responsibilities: Engage a qualified testing agency to perform quality-control services indicated as Owner's responsibility.

B. Contractor Responsibilities: Quality-control services specified and required by authorities having jurisdiction.

C. Manufacturer's field services.

D. Associated Services: Access to the Work, taking and storing samples.

E. Special Tests and Inspections: Owner will engage a testing agency and a special inspector to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner.

F. Test and inspection log.

G. Repair and Protection: Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 01400

SECTION 01782 - OPERATION AND MAINTENANCE DATA

1.1 SUMMARY

A. Operation and maintenance manuals.

1.2 PRODUCTS

A. Manuals: Heavy-duty, three-ring, vinyl-covered, loose-leaf binders, two printed copies and two digital copies.

B. Operation Manuals: System and equipment descriptions, operating procedures, wiring diagrams, control diagrams and sequence of operation, and piped system diagrams.

C. Product Maintenance Manuals: Source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds.

D. System and Equipment Maintenance Manuals: Source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranties and bonds.

END OF SECTION 01782

SECTION
01800 - COMMISSIONING

1. SUMMARY
   a. Systems to be Commissioned

      1) Plumbing Systems:
         a) Energy Consuming Plumbing Equipment and systems
      2) Mechanical Systems:
         a) Mechanical HVAC Systems
         b) Building BMCS Controls
      3) Electrical:
         a) Normal Power Systems
         b) Emergency Power Generators and ATSs
         c) Lighting Control Systems
         d) Daylight Dimming Control Systems
         e) Variable Frequency Controllers

   b. Commissioning Team

      1) Members representing each Contractor, including Project superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by the CxA.
      2) Members representing Owner, including CxA, facility user, and operation and maintenance personnel, and Architect and engineering design professionals.

   c. Owner's Responsibilities:

      1) Provide OPR documentation.
      2) Assign operation and maintenance personnel and schedule them for commissioning activities.

   d. Contractor's / Designer’s Responsibilities:

      1) Provide BoD documentation.
      2) Assign personnel and schedule them for commissioning activities.
      3) Complete Installation Checklists and Functional Tests.
      4) Coordinate, schedule, and report on all commissioning activities among subcontractors.
      5) Provide Requested equipment and system information to CxA for Systems Manual.

   e. CxA's Responsibilities:

      1) Organize and lead commissioning team.
      2) Provide commissioning plan.
      3) Review Basis of Design Document for compliance to Owners Project Requirements (OPR).
      4) Review Design Submittals for compliance to Owners Project Requirements.
      5) Review Operation and Maintenance (O&M) training program.
      6) Review and Comment on construction submittals related to Commissioned Systems.
      7) Convene commissioning team meetings.
      8) Provide Project-specific checklists and test procedures.
      9) Verify the execution of commissioning process activities using random sampling.
      10) Inspect construction to verify compliance with the OPR, BoD, and Contract Documents
      11) Prepare and maintain Issues Log.
      12) Verify systems, assemblies, equipment, and component startup.
      13) Compile test data, inspection reports, and certificates; include them in the systems manual and commissioning process report.

SECTION 01820 - DEMONSTRATION AND TRAINING

1.1 SUMMARY

A. Demonstration and training in operation and maintenance of operation of systems and equipment.

B. Demonstration and training DVDs.

1.2 INSTRUCTION PROGRAM

A. Program Structure: Training modules for each system and equipment not part of a system, including the following:

1. Basis of system design, operational requirements, and criteria.
2. Documentation.
3. Emergencies.
4. Operations.
5. Adjustments.
6. Troubleshooting.
7. Maintenance.
8. Repairs.

B. Facilitator to prepare instruction program and training modules.

C. Evaluation: Demonstration performance-based test.

END OF SECTION 01820

SECTION 02221 - BUILDING DEMOLITION

1.1 SUMMARY

A. Demolition and removal of buildings and site improvements.

1.2 QUALITY ASSURANCE

A. Quality Standard: ANSI A10.6 and NFPA 241.

1.3 PROJECT CONDITIONS

A. Hazardous Materials: Owner will arrange removal prior to start of the Work.

1.4 MATERIALS

A. Satisfactory Soils: Division 2 Section "Earthwork."

1.5 EXAMINATION

A. Perform an engineering survey of condition of buildings.

1.6 PREPARATION

A. Refrigerant: If any, remove according to 40 CFR 82.

B. Utility Shut Off: Owner.

1.7 DEMOLITION

A. Use of explosives is not permitted.

B. Salvage: Owner will salvage what they desire in advance of demolition

C. Below-Grade Construction: Demolish completely.

1. Remove completely to what ever depth is required.

D. Existing Utilities: Demolish completely back to point identified by Snow College.

1.8 SITE RESTORATION

A. Below-Grade Areas: Fill per requirements of Earthwork Section

1.9 DISPOSAL OF DEMOLISHED MATERIAL

A. Remove demolished material from site and dispose of in an EPA-approved landfill.

END OF SECTION 02221

SECTION 02230 - SITE CLEARING

1.1 SUMMARY

A. Removing existing trees, plants and grass.

B. Clearing and grubbing obstructions, trees, shrubs, grass, and other vegetation including grinding stumps and removing roots and debris.

C. Stripping and stockpiling topsoil and stockpiling surplus topsoil.

D. Providing temporary erosion and sedimentation control measures.

END OF SECTION 02230

SECTION 02300 - EARTHWORK

1.1 SUMMARY

A. Preparing subgrades for slabs-on-grade walks pavements lawns and grasses exterior plants.

B. Excavating and backfilling or filling for buildings and structures, including footings and foundations .

C. Excavating and backfilling for utility trenches.

D. Excavation: Unclassified.

E. Grading.

F. Subsurface drainage backfill for walls and trenches.

G. Detectable warning tape for non metallic utilities.

H. Subbase course for concrete walks and pavements.

I. Drainage course for cast-in-place concrete slabs-on-grade.

1.2 MATERIALS

A. Soil Materials:

1. Satisfactory Soils: ASTM D 2487 soil classification groups.
2. Unsatisfactory Soils: ASTM D 2487 soil classification groups.
3. Backfill and Fill: Satisfactory soil materials.
4. Subbase Course: Natural or crushed gravel, crushed stone, and natural or crushed sand.
5. Engineered Fill: Natural or crushed gravel, crushed stone, and natural or crushed sand.
6. Bedding Course: Natural or crushed gravel, crushed stone, and natural or crushed sand.
7. Drainage Course: Crushed stone, or crushed or uncrushed gravel.
8. Filter Material: Natural or crushed gravel, or crushed stone and natural sand.
9. Sand: Natural or manufactured.
10. Impervious Fill: Clayey gravel and sand mixture.

B. Controlled low-strength material.

C. Warning Tape: Detectable polyethylene film.

1.3 EXCAVATION

A. Explosives: Not permitted.

B. Disposal of Surplus and Waste Materials: Off Owner's property.

1.4 FIELD QUALITY CONTROL

A. Geotechnical Testing Agency: Owner engaged.

END OF SECTION 02300

SECTION 02510 - WATER DISTRIBUTION

1.1 SUMMARY

A. Combined water service and fire-service mains outside the building.

1.2 SUBMITTALS

A. Coordination Drawings.

1.3 QUALITY ASSURANCE

A. Quality Standard for Electrical Components, Devices, and Accessories: NFPA 70.

B. Quality Standard for Materials, Installations, Tests, Flushing, and Valve and Hydrant Supervision for Fire-Service-Main Piping: NFPA 24.

C. Quality Standard for Plastic Potable-Water-Service Piping: NSF 14. Include marking "NSF-pw" on piping.

D. Quality Standard for Water-Service Piping and Specialties for Domestic Water: NSF 61.

E. Quality Standard for Fire-Service-Main Products: FMG's "Approval Guide."

1.4 MATERIALS

A. Underground Water-Service Piping NPS 3/4 to NPS 3:

1. Type K hard copper tube and copper solder-joint fittings.

B. Underground Combined Water-Service and Fire-Service-Main Piping:

1. Ductile-iron.

C. Piping Specialties:

1. Transition fittings.
2. Tubular-sleeve pipe couplings.
3. Split-sleeve pipe couplings.
4. Flexible connectors.
5. Dielectric fittings.

D. Corrosion-Protection Piping Encasement: Required.

1.5 MANUFACTURED UNITS

A. Gate Valves:

1. Cast Iron: OS&Y, rising stem, C509, 250 psig.
2. UL/FMG, Cast Iron: OS&Y, rising stem.
3. Bronze: UL/FMG, OS&Y, rising stem.

B. Check Valves: UL/FMG, 250 psig.

C. Butterfly Valves: UL/FMG.

D. Backflow Preventers:

1. Double-check, backflow-prevention assemblies. This valve must be serviceable “in line” and have test cocks and ball valves on both sides for testing

END OF SECTION 02510

SECTION 02530 - SANITARY SEWERAGE

1.1 SUMMARY

A. Gravity-flow, nonpressure sanitary sewerage outside the building.

1.2 PERFORMANCE REQUIREMENTS

A. Gravity-Flow, Nonpressure, Drainage-Piping Pressure Rating: 10-foot head of water.

1.3 COMPONENTS

A. Cleanouts: PVC.

B. Manholes: Standard precast concrete.

1. Resilient pipe connectors.
2. Reinforced-concrete grade rings.
3. Manhole frames and covers.

1.4 INSTALLATION

A. Gravity-Flow, Nonpressure Sewer Piping Applications:

1. NPS 4: PVC sewer; or cast iron.
2. NPS 5 and NPS 6: PVC sewer; or cast iron.
3. NPS 8 and NPS 10: PVC sewer; or cast iron.

END OF SECTION 02530

SECTION 02630 - STORM DRAINAGE

1.1 SUMMARY

A. Gravity-flow, non-pressure storm drainage outside the building.

1.2 PERFORMANCE REQUIREMENTS

A. Gravity-Flow, Nonpressure, Drainage-Piping Pressure Rating: 10-foot head of water.

1.3 COMPONENTS

A. Cleanouts: PVC.in landscape; cast iron in paving.

B. Drains: Gray-iron area drains.

C. Manholes: Standard precast concrete.

1. Resilient pipe connectors.
2. Reinforced-concrete grade rings.
3. Manhole frames and covers.

D. Catch Basins: Standard precast concrete.

1. Cast iron frames and grates.

E. Stormwater Inlets: gutter type.

1.4 INSTALLATION

A. Gravity-Flow, Nonpressure Sewer Piping Applications:

1. NPS 4 to NPS 6: PVC sewer pipe.
2. NPS 8 to NPS 12: PVC sewerpipe.
3. NPS 15: PVC profile gravity sewer pipe.
4. NPS 18 to NPS 36: PVC sewer pipe.

END OF SECTION 02630

SECTION 02751 - CEMENT CONCRETE PAVEMENT

1.1 SUMMARY

A. Curbs and gutters.

B. Walkways.

C. Roads/parking lots- (consider porous concrete)

1.2 QUALITY ASSURANCE

A. Quality Standard: ACI 301, "Specification for Structural Concrete."

1.3 MATERIALS

A. Reinforcement:

1. Reinforcing Bars and Tie Bars: Epoxy-coated deformed or Galvanized deformed steel.
2. Synthetic Fiber: Fibrillated polypropylene at the rate of 1.5#/CY.
3. Welded wire mesh not allowed.

B. Concrete:

1. Portland Cement: ASTM C 150 withFly Ash: ASTM C 618, Class F; maximum 15% by weight
2. Aggregate: Normal-weight aggregate.
3. Admixture: Air entraining- 6.5% plus-or-minus 1.5%.
4. Compressive Strength: 4000 psi at 28 days.
5. Cement Content: Minimum 576 lb per cubic yard.
6. Water/Cement Ratio: 0.45%.
7. Maximum Slump: 3 inches

C. Wet Curing Blanket:

1. AquaCure by DRC industries.
2. UltraCure NCF by McTech Group.

D. Related Materials:

1. Expansion- and Isolation-Joint-Filler Strips: Cellulosic fiber with “Void Cap” strip for sealant.
2. Sealer: Aquapel Plus by L&M Construction Chemical, or equal.
3. Joint Sealant: See section 07900.

1.4 FINISHING

A. Finishes: Medium-to-coarse-textured broom finish and cured with wet curing blanket, then sealed.

1.5 FIELD QUALITY CONTROL

A. Testing: By Owner-engaged agency.

END OF SECTION 02751

SECTION 02810 - IRRIGATION SYSTEMS

1.1 PERFORMANCE REQUIREMENTS

A. Irrigation zone control shall be automatic operation with controller and automatic control valves.

B. Minimum Working Pressures:

1. Irrigation Main Piping: 200 psig.
2. Circuit Piping: 150 psig.

1.2 UNDERGROUND IRRIGATION MAIN PIPING

A. Pipe:

1. Schedule 40 PVC pipe and Schedule 80 PVC or “Harco” ductile iron socket fittings, and solvent-cemented joints.

1.3 CIRCUIT PIPING

A. Pipe:

1. PVC, pressure-rated pipe; Schedule 40, PVC socket fittings; solvent-cemented joints.

1.4 DRAIN PIPING

A. Schedule 40, PVC pipe and socket fittings; and solvent-cemented joints.

1.5 BRONZE BALL VALVES:

A. Apollo Ball Valves; Conbraco Industries, Inc.

B. Watts Ball Valves

C. Size to match that of electric control valve it is isolating and be installed in the same box.

1.6 BRONZE, AUTOMATIC CONTROL VALVES:

A. Rain Bird Sprinkler Mfg. Corp.

1.7 PLASTIC, AUTOMATIC CONTROL VALVES

A. Rain Bird Sprinkler Mfg. Corp.

1.8 CONTROL-VALVE BOXES:

A. AMETEK; Plymouth Products Div.

B. Carson-Brooks Plastics, Inc.

1.9 QUICK COUPLERS AND KEYS:

A. Rain Bird Sprinkler Mfg. Corp.

1.10 SPRINKLERS:

A. Rain Bird Sprinkler Mfg. Corp.

1.11 MISCELLANEOUS SPECIALTIES:

A. Rain Bird Sprinkler Mfg. Corp.

B. Netafim

1.12 CONTROLLERS:

A. Rain Bird Sprinkler Mfg. Corp.

1.13 BACKFLOW PREVENTER

A. Valve shall be tested to withstand pressures of 175 psi and meeting ASSE, CSA, IAPMO listed, SBCCI, USC approvals.

B. This valve must be serviceable “in line” and have test cocks and ball valves on both sides for testing

C. The Double Check assembly shall be installed underground in a vault big enough to be serviced in line.

1.14 DRIP IRRIGATION SYSTEM

A. The valves to be used shall be Netafim 23N0B-041 Fast or 23N0B-05-04 Thread

1.15 DRIP SYSTEM PRESSURE REGULATION VALVE

A. The valve shall be a Toro Model Number PRV31-3/4HF45.

1.16 DRIP SYSTEM DISC FILTER

A. The filter shall be a Toro Model Number DF150-140 with a maximum flow of 20 GPM and a maximum pressure loss of 5 PSI.

1.17 DRIP SYSTEM AIR VACUUM / RELIEF VALVE

A. All Techline systems shall utilize Netafim Air Relief Valves

1.18 GATE VALVES

A. American Flow Control

1.19 PRESSURE REDUCING VALVE

A. Bermad Control Valves

B. CLA-VAL Co.

1.20 CAST - IRON FITTINGS

A. HARCO DEEP BELL; The Harrington Corporation of Lynchburg, VA.

1.21 CONTROL WIRING

A. UL 493, Type UF, solid-copper-conductor, insulated cable, suitable for direct burial.

1.22 DRAIN VALVES

A. NPS ½ and NPS 3/4: Bronze gate valve.

B. NPS 1 to NPS 2: Bronze gate valve.

1.23 SLEEVES

A. 4" PVC 18" - 24" for mainline and control wires, 12" to 18" for lateral lines.

B. Install 18" past all hard surfaces- provide with detectable warning tape.

END OF SECTION 02810

SECTION 02920 - LAWNS AND GRASSES

1.1 SUMMARY

A. Sodded turf.

1.2 MAINTENANCE SERVICE

A. Turf: 120 days from date of Substantial Completion.

B. Mowing: Maintain to minimum height of 3".

C. Fertilizing: Three times at six week intervals at a rate of 4 pounds per 1000 square feet.

1.3 MATERIALS

A. Turfgrass Sod: Two year old Kentucky Blue Grass.

1. Must be cut fresh the morning of installation- any sod not laid within 24 hours of cutting shall be deemed unacceptable.

B. Planting Soils: Existing, in-place surface soil, amended with inorganic and organic soil amendments and fertilizers in specified quantities.

C. Pesticides.

D. Fertilizer.

1.4 INSTALLATION

A. Planting Soil Depth for Newly Graded Subgrades: 4 inches.

B. Surface Soil Enrichment Depth for Unchanged Subgrades: 4 inches.

END OF SECTION 02920

SECTION 02930 - EXTERIOR PLANTS

1.1 WARRANTY

A. Trees, Shrubs, Vines, and Ornamental Grasses: 12 months. Replacements shall be maintained for four growing months after replacement.

B. Ground Covers, Biennials, Perennials, and Other Plants: 12 months. Replacements shall be maintained for four growing months after replacement.

C. Annuals: Three months.

1.2 MAINTENANCE SERVICE

A. Trees and Shrubs: Four consecutive growing months (growing months defined as April, May, June, July, August and September).

B. Ground Cover and Other Plants: Four consecutive growing months.

C. Maitenance includes watering, weeding, cultivation, fertilizing, controlling insects and diseases, re-guying and staking and all other operations of care necessary for the promotion of root growth and plant life.

1.3 MATERIALS

A. Plants, General: Nursery-grown and complying with ANSI Z60.1.

B. Annuals and Biennials: Healthy and acclimated to outdoor conditions.

C. Planting Soils: Existing, in-place surface soil, amended with inorganic and organic soil amendments and fertilizers in specified quantities.

D. Lightweight On-Structure Planting Soil: Modified planting soil.

E. Mulches: Must be approved by Snow College grounds manager.

F. Weed-Control Barriers: Nonwoven fabric.

G. Herbicides: Registered and approved by EPA pre-emergent and post-emergent herbicide(s).

H. Fertilizer: Commercial, O-F-241C, type 1, grade 16-16-8, Level B

I. Tree Stabilization: Upright staking and tying.

J. Landscape Edgings: Concrete.

K. Root barrier.

1.4 INSTALLATION

A. Planting Soil Depth: 6 inches.

B. Pruning.

C. Ground Cover and Plant Planting: Space ground cover and plants other than trees, shrubs, and vines 24 inches apart in even rows with triangular spacing.

D. Mulching:

1. Trees and Tree-like Shrubs in Turf Areas: Organic mulch ring of 2-inch thickness with 12-inch-24-inch radius- material to be approved by Snow College grounds manager.
2. Planting Areas: 2-inch average thickness of organic mulch extending 12 inches beyond edge of individual planting pit or trench and over whole surface of planting area- material to be approved by Snow College grounds manager.

END OF SECTION 02930

Section 03300 - CAST-IN-PLACE CONCRETE

1.1 SUMMARY

A. Cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:

1. Footings.
2. Foundation walls.
3. Slabs-on-grade.
4. Suspended slabs.

1.2 QUALITY ASSURANCE

A. Quality Standard: ACI 301.

B. Mockups to demonstrate typical joints, surface finish, texture, tolerances, and standard of workmanship.

1.3 MATERIALS

A. Form-facing materials: For exposed concrete use MDO or HDO plywood, minimum 3/4" thick.

B. Steel Reinforcement:

1. Reinforcing Bars: Deformed Steel bar mats.

C. Concrete Materials:

1. Portland Cement: ASTM C 150, Type I/II, gray, supplemented with no more than 15% fly ash.
2. Aggregate: Normal weight and light weight
3. Water.
4. Admixtures: High range, water reducing.
5. Pigments: Inorganic

D. Curing Materials: Clear, waterborne, membrane-forming curing, dissipating compound.

E. Sealer: Seal floors to be left exposed.

F. Related Materials: Expansion- and isolation-joint-filler strips.

1.4 CONCRETE MIXTURES

A. Compressive Strength (28 Days):

1. Footings: 4500 psi.
2. Foundation Walls: 4500 psi.

3. Slabs-on-Grade (interior): 4000 psi.
4. Suspended Slabs (interior) 4000 psi

B. Mixing: Ready mixed.

1.5 INSTALLATION

A. Formed-Surface Finish: Smooth.

B. Floor and Slab Finishes:

1. Scratch: Surfaces to receive mortar setting beds for bonded cementitious floor finishes.
2. Trowel: Surfaces exposed to view, and surfaces to be covered with resilient flooring carpet ceramic or quarry tile set over a cleavage membrane thin film-finish coating system.

1.6 FIELD QUALITY CONTROL

A. Testing: By Owner-engaged agency.

B. Inspections: By Owner-engaged special inspector.

END OF SECTION 03300

SECTION 03450 - ARCHITECTURAL PRECAST CONCRETE

1.1 SUMMARY

A. Architectural precast concrete trim units (sills, lintels, trim).

1.2 PERFORMANCE REQUIREMENTS

A. Structural Performance: Fabricator to design architectural precast concrete units.

1.3 QUALITY ASSURANCE

A. Installer: PCI-certified erector.

B. Fabricator: PCI-certified plant.

C. Design Standards: ACI 318 and PCI MNL 120.

D. Quality-Control Standard: PCI MNL 117.

E. Sample panels for each finish, color, and texture variation.

F. Mockups.

G. Preconstruction testing mockup.

1.4 MATERIALS

A. Reinforcing Materials:

1. Reinforcing Bars: Epoxy-coated steel

B. Concrete Materials:

1. Portland Cement: ASTM C 150, Type I or Type III.
2. Supplementary Cementitious Materials: Fly ash.
3. Aggregates: Normal weight.
4. Coloring admixture: Mineral based.
5. Admixtures: Air entraining and water reducing,

C. Steel Connections High-strength bolts and nuts.

1. Finish: Galvanized.

D. Grout: Nonmetallic, nonshrink.

E. Latex-portland cement pointing grout for thin brick unit joints.

F. Stone facing specified in Division 4 with stainless-steel anchors.

1.5 CONCRETE MIXTURES

A. Compressive Strength (28 Days):

1. Normal-Weight Concrete Face and Backup Mixtures: 5000 psi.
2. Lightweight Concrete Backup Mixtures: 5000 psi.

1.6 FABRICATION

A. Finishes: As designed.

1.7 FIELD QUALITY CONTROL

A. Special Inspections: By Owner-engaged agency.

B. Testing and Inspections: By Owner-engaged agency.

END OF SECTION 03450

SECTION 04810 - UNIT MASONRY ASSEMBLIES

1.1 SUMMARY

A. Masonry Construction:

1. Single-wythe masonry.
2. Cavity walls.
3. Masonry veneer.
4. Installation of pre-cast trim.

1.2 PERFORMANCE REQUIREMENTS

A. Net-Area Compressive Strengths (f'_m) of Structural Unit Masonry: As indicated.

B. Determine net-area compressive strength (f'_m) of masonry by testing masonry prisms.

1.3 QUALITY ASSURANCE

A. Preconstruction Testing Service: Owner engaged, with payment by Owner.

B. See Section 01400 QUALITY for mock-up requirements.

1.4 MATERIALS

A. Concrete Masonry Units (CMUs):

1. Units made with integral water repellent for exposed units.
2. Concrete Masonry Units: Lightweight or normal weight. 8" x 8" x 16"; 8" x 10" x 16" modular

B. Sills, Lintels and trim pieces: precast concrete.

C. Brick: Face brick. 2 1/4" H x 7 5/8" L x 3 5/8" D ASTM C-216; FBS; FBX; SW modular brick.

1. Snow College has approximately 80,000 face brick available to the Contractor at no cost. The brick is stored at the Baseball Complex by the College, delivery to the site is the Contractor's responsibility.

D. Reinforcing Steel: Uncoated steel bars.

E. Masonry Joint Reinforcement:

1. Interior Walls: Mill carbon steel.
2. Exterior Walls: Hot-dip galvanized steel.

F. Ties and Anchors: Hot-dip Galvanized steel.

1. Adjustable Masonry-Veneer Anchors: Seismic (ties to engage horiz. joint reinforcement).

G. Embedded Flashing:

1. Concealed (Flexible) Flashing: asphalt/fabric-coated copper.

a. Used with flashing terminations.

2. Exposed Flashing: Stainless Steel- 2B dull mill finish, 24 GA. Extend per Utah IBC ammendment.

H. Weep/Vent Holes: Designer's option but at least every 32".

I. Cavity drainage material: "Mortar Net", or equal

J. Reinforcing bar positioners.

K. Cavity-Wall Insulation: Extruded-polystyrene board.

L. Mortar.

1. Masonry cement and mortar cement not allowed.
2. Integral water repellent by same manufacturer as CMU water repellent for CMU exposed to weather.

1.5 SOURCE QUALITY CONTROL

A. Testing Agency: Owner engaged, with payment by Owner.

1.6 INSTALLATION

A. Bond Pattern: As designed- running bond recommended.

B. Joints to be concave tooled. With Owner's permission, "weather raked" joints will be considered.

1.7 FIELD QUALITY CONTROL

A. Testing Agency: Owner engaged, with payment by Owner.

END OF SECTION 04810

SECTION 05120 - STRUCTURAL STEEL

1.1 SUMMARY

A. Structural-steel framing.

1.2 QUALITY ASSURANCE

A. Fabricator Qualifications: AISC-Certified Plant.

B. Quality Standard: AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design."

1.3 MATERIALS

A. Structural-Steel Shapes: Tube and W shapes.

B. Bolts, Nuts, and Washers: High strength.

C. Connectors: Shear connectors.

D. Primer: Fabricator's standard, nonasphaltic.

E. Grout: Nonmetallic, shrinkage resistant.

1.4 FABRICATION

A. Shop Connections: high-strength bolts and welded connections.

B. Fabricator must be approved by DFCM.

C. Surface Preparation: SSPC-SP 2.

D. Galvanizing: Hot dip for ferrous metal exposed to weather.

1.5 SOURCE QUALITY CONTROL

A. Testing Agency: Owner engaged.

1.6 INSTALLATION

A. Field Connections: high-strength bolts and welded connections.

1.7 FIELD QUALITY CONTROL

A. Testing Agency: Owner engaged.

END OF SECTION 05120

SECTION 05210 - STEEL JOISTS

1.1 SUMMARY

A. Open-web K-series steel joists for floor and roof framing.

B. KCS-type, open-web K-series steel joists for floor and roof framing.

C. Joist girders for floor and roof framing.

D. Joist accessories, including permanent bridging.

1.2 MATERIALS

A. Bolts: High-strength carbon steel.

1. Finish: Plain, uncoated.

B. Primer: SSPC-Paint 15.

C. Open-Web K-Series Steel Joists.

D. Joist Girders:

1. End Arrangement: Underslung.
2. Top-Chord Arrangement: Parallel.

1.3 INSTALLATION

A. Connections: Welded.

1.4 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage testing agency to inspect field welds and bolted connections.

END OF SECTION 05210

05310 - STEEL DECK

1.1 SUMMARY

A. Roof deck.

B. Composite floor deck.

1.2 QUALITY ASSURANCE

A. FMG Listing: Steel roof deck.

1.3 MATERIALS

A. Roof Deck: Galvanized steel sheet.

1. Profile Depth: As determined by structural design.
2. Gauge: As determined by structural design.
3. Galvanizing: G90 coating.

B. Composite Floor Deck: Galvanized steel sheet.

1. Profile Depth: As determined by structural design.
2. Gauge: As determined by structural design.
3. Galvanizing: G60 coating.

C. Accessories: Flexible closure strips, pour stops, girder fillers, column closures, end closures, Z-closures, and cover plates, recessed sump pans and flat sump plates.

1.4 INSTALLATION

A. Roof Deck: Welded, or fastener attached where appropriate.

B. Floor Deck: Welded, or fastener attached where appropriate..

1.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner engaged.

END OF SECTION 05310

SECTION 05400 - COLD-FORMED METAL FRAMING

1.1 SUMMARY

A. Exterior non-load-bearing wall framing.

B. Exterior and Interior load bearing wall framing.

C. Exterior sheathing.

1.2 QUALITY ASSURANCE

A. Design Standard: AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members" and its "Standard for Cold-Formed Steel Framing - General Provisions."

1.3 MATERIALS

A. Steel Sheet: ASTM A 1003/A 1003M, Structural Grade, metallic coated.

B. Exterior Non-Load-Bearing and Load-Bearing Wall Framing: Standard C-shaped, punched steel studs and U-shaped, unpunched track.

1. Minimum Steel Thickness: 16 ga.
2. Design for vertical deflection, unless load bearing.

C. Framing Accessories: Supplementary framing bracing, bridging, and solid blocking stud kickers and girts.

D. Sheathing: Glass mat exterior gypsum sheathing- DensGlass or equal.

E. Insulation for inaccessible voids.

1.4 INSTALLATION

A. Fasten framing by welding.

1. Exterior Non-Load-Bearing and Load Bearing Wall Stud Spacing: Consider 24 inches to minimize insulation deration.

1.5 FIELD QUALITY CONTROL

A. Testing: By Owner-engaged agency- if required.

END OF SECTION 05400

SECTION 05500 - METAL FABRICATIONS

1.1 SUMMARY

A. Miscellaneous metal framing and supports.

B. Loose metal plates and shapes.

C. Miscellaneous fabricated metal items.

1.2 PRODUCTS

A. Materials: Steel plates, shapes, and bars Steel tubing Steel pipe Slotted channel framing.

B. Miscellaneous Framing and Supports:

1. Steel framing and supports for overhead doors countertops applications where framing and supports are not specified in other Sections.
2. Galvanize at exterior locations.
3. Prime with zinc-rich primer at interior locations.

C. Loose bearing and leveling plates , primed with zinc-rich primer.

D. Miscellaneous Steel Trim: .

1. Galvanize exterior locations.
2. Prime interior locations with zinc-rich primer.

E. Metal Ladders: Steel.

1. Prime interior locations with zinc-rich primer.

F. Metal Bollards: Schedule 40 steel pipe- galvanized.

END OF SECTION 05500

SECTION 05521 - PIPE AND TUBE RAILINGS

1.1 SUMMARY

A. Stainless-steel pipe and tube hand rails.

1. Type 304 interior.
2. Type 316 exterior.

1.2 FABRICATION

A. Changes in Direction of Members: By bending or by inserting prefabricated fittings.

B. Connections: Welded.

1.3 FINISHES.

A. Stainless Steel: Directional satin, No. 4.

END OF SECTION 05521

SECTION 06105 - MISCELLANEOUS CARPENTRY

1.1 SUMMARY

A. Sheathing for nailing asphalt shingles.

B. Wood blocking and nailers.

C. Plywood backing panels.

1.2 MATERIALS

A. Wood-Preservative-Treated Materials:

1. Preservative Treatment: AWPA C2 with chemicals containing no arsenic or chromium.

   a. AWPA C31 (inorganic boron) may be used in protected locations.

2. Application: Items indicated and the following:

   a. Items in contact with roofing or waterproofing.
   b. Items in contact with concrete or masonry.

B. Fire-Retardant-Treated Materials:

1. Application: Items indicated and the following:

   a. Concealed blocking.
   b. Plywood backing panels.

C. Dimension Lumber Framing:

1. Maximum Moisture Content: 19 percent.
2. Other Framing: Construction or No. 2 grade hem-fir.

D. Plywood backing panels for telephone and electrical equipment.

E. Fasteners: Hot-dip galvanized steel where exposed to weather, in ground contact, in contact with treated wood, or in area of high relative humidity.

F. Metal Framing Anchors:

1. Metal: Hot-dip galvanized steel.

END OF SECTION 06105

SECTION 06402 - INTERIOR ARCHITECTURAL WOODWORK

1.1 SUMMARY

A. Interior standing and running trim.

B. Wood and plastic-laminate cabinets.

C. Solid-surfacing-material countertops.

D. Closet and utility shelving.

1.2 QUALITY ASSURANCE

A. Quality Standard: AWI.

1.3 MATERIALS

A. Wood Species and Cut for Transparent Finish: Red oak, plain sawn or sliced.

B. Composite Wood Products: Made without urea formaldehyde.

C. Cabinet Hardware:

1. Hinges: Frameless, concealed.
2. Pulls: Back mounted Wire.
3. Exposed Hardware Finishes: Satin chromium plated.

D. Interior Woodwork Grade: Custom.

E. Interior Standing and Running Trim for Transparent Finish:

1. Grade: Custom.
2. Wood Species and Cut: Red oak, plain sawn.

F. Wood Cabinets for Transparent Finish:

1. Grade: Custom.
2. AWI Type of Cabinet Construction: Flush overlay.
3. Wood Species and Cut for Exposed Surfaces: Red oak, plain sawn or cut.
4. Cabinet Interior: Thermoset decorative panels.

G. Plastic-Laminate Cabinets:

1. Grade: Custom.
2. AWI Type of Cabinet Construction: Flush overlay.

3. Cabinet Interior: Thermoset decorative panels.

H. Solid-Surfacing-Material Countertops:

1. Grade: Custom.
2. Thickness: ½ inch.

I. Closet and Utility Shelving: Custom grade.

J. Shop Finishing:

1. Grade: Same grade as woodwork.
2. Extent: All woodwork shop finished.

END OF SECTION 06402

SECTION 07210 - BUILDING INSULATION

1.1 SUMMARY

A. Applications:

1. Perimeter insulation under slabs-on-grade.
2. Cavity-wall insulation.
3. Concealed building insulation.
4. Exposed building insulation.
5. Vapor retarders.
6. Sound attenuation insulation.
7. Under Slab vapor retarder.
8. Air barrier material.

1.2 PERFORMANCE REQUIREMENTS

A. Plenum Rating: Glass-fiber insulation rated for resistance against erosion and mold growth per UL 181.

1.3 MATERIALS

A. Insulation:

1. Extruded-Polystyrene Board: Type X, 1.30 lb/cu. ft.
2. Foil-Faced Polyisocyanurate Board: Type I, Class 1 or 2..
3. Unfaced Glass-Fiber Blanket: Type I.
4. Sprayed expanding closed cell foam.

B. Vapor Retarders: FSK-25, Foil-scrim-kraft w/flame spread of 25 or less- tape all joints.

C. Under slab vapor retarders: Reinforced LDPE membrane- tape all joints

D. Air barrier Coating: Cold-fluid-applied, vapro permeable, elastomeric waterproofing membrane.

1. Material: Water-based acrylic or polymer-modified bitumen, with VOC content of zero
2. Dry film thickness: 7 mills minimum.
3. Air permeance: 0.004 cubic feet per square foot, maximum when tested in accordance with ASTM E 2178.
4. Water Vapor Permeance: 10 perms, minimum, when tested in accordance with ASTM E96/E.
5. Products:
   a. BASF Corp, ENERSHIELD-HP
   b. Epro Services, ECOFLEX-PS

E. Auxiliary Insulating Materials:

1. Insulation fasteners.

END OF SECTION 07210

SECTION 07241 - POLYMER-BASED EXTERIOR INSULATION AND FINISH SYSTEM (EIFS)

1.1 SUMMARY

A. Exterior insulation and finish system (EIFS) applied over concrete, masonry, gypsum sheathing and/or plywood sheathing.

B. Prefabricated panels consisting of EIFS applied over gypsum sheathing on metal framing.

1.2 PERFORMANCE REQUIREMENTS

A. Prefabricated Panels:

1. Basic Wind Speed: 90 MPH
2. Engineering design by Contractor.

1.3 QUALITY ASSURANCE

A. Fire-Resistance Characteristics: Tested per ASTM E 119.

B. Fire Test: Full-scale multistory per UBC Standard 26-4.

C. Mockups for each form of construction and finish.

D. ICC report required.

1.4 MATERIALS

A. Flexible-Membrane Flashing: Cold-applied, fully self-adhering, self-healing, rubberized-asphalt.

B. Insulation Adhesive: Factory-mixed noncementitious.

C. Board Insulation: Molded, rigid cellular polystyrene.

D. Reinforcing Mesh: Standard impact.

E. Base-Coat Materials: Factory-blended polymer-emulsion adhesive and portland cement dry mix to which only water is added.

F. Finish-Coat Materials: Standard acrylic-based coating.

G. Trim Accessories: PVC.

1. Type: Casing bead, Drip screed/track, Expansion joint and Window sill flashing.

H. Elastomeric Sealants: Multicomponent, nonsag urethane.

1.5 FABRICATION

A. Prefabricated Panel Framing Connections: Welded.

1.6 SOURCE QUALITY CONTROL

A. Testing Agency: Owner engaged.

1.7 INSTALLATION

A. Insulation: Adhesively and mechanically attached to substrate.

B. Expansion Joints:

1. Where required by EIFS manufacturer.
2. Where expansion joints are in substrates behind EIFS.
3. Where EIFS adjoin dissimilar substrates, materials, and construction.
4. Where wall height changes.

C. Double-Layer Reinforcing Mesh Application: If used at grade.

D. Double Base-Coat Application: If used at grade.

E. Finish Coat: Applied over base coat.

F. Panels: Welded to structural-steel frame.

1.8 FIELD QUALITY CONTROL

A. Special Inspections and Testing: By Owner-engaged agency].

END OF SECTION 07241

SECTION 07311 - ASPHALT SHINGLES

1.1 SUMMARY

A. Asphalt shingles.

B. Underlayment.

1.2 QUALITY ASSURANCE

A. Exterior Fire-Test Exposure: Class A; ASTM E 108 or UL 790.

B. Mockup of each form of construction.

1.3 WARRANTY

A. Material Warranty Period: 50 years (remember this requires ventilation space under the sheathing.

B. Workmanship Warranty Period: 10 years.

C. Roofing Installer's Warranty: Two years.

1.4 PRODUCTS

A. Glass-Fiber-Reinforced Asphalt Shingles: Double fiberglass mat constructed with a random cut sawtooth design. The two layers of mat are coated with asphalt and then laminated together and surfaced with mineral granules. A self sealing strip of asphalt is provided for added wind resistance. 12" wide x 36" long, with a 5" exposure type.

1. Hip and Ridge Shingles: Standard units.

B. Underlayment: Felt(s) and Self-adhering sheet underlayment, polyethylene faced.

C. Ridge Vents: Rigid, high-density plastic.

D. Metal Flashing and Trim: Color-Clad galvanized sheet metal for step flashing, Pre-finished aluminum for drip edges, and Oatey rebber seal pipe jack flashing.

1. Types: Step flashings cricket flashings drip edges and vent pipe flashings.

1.5 INSTALLATION

A. Underlayment: Single-layer felt(s).

B. Ice-Dam Membrane: Self-adhering sheet- “Ice and Water Shield”- extend 30" above inside face of perimeter walls, and 30" either side of all valleys and ridges.

C. Installation Standard: Install asphalt shingles according to manufacturer's written instructions, recommendations in ARMA's "Residential Asphalt Roofing Manual," and asphalt shingle recommendations in NRCA's "The NRCA Roofing and Waterproofing Manual."

D. Shingles shall be nailed- staples are not acceptable.

E. Valleys: Sheet metal valleys.

END OF SECTION 07311

SECTION 07542 - POLYVINYL-CHLORIDE (PVC) ROOFING

1.1 SUMMARY

A. Adhered PVC membrane roofing system.

B. Roof insulation.

1.2 PERFORMANCE REQUIREMENTS

A. Roofing System Design: Uplift pressures calculated according to ASCE/SEI 7.

B. FM Approvals Listing: Class 1A-90.

1.3 QUALITY ASSURANCE

A. Exterior Fire-Test Exposure: Class A.

B. Preliminary roofing and preinstallation conference.

1.4 WARRANTY

A. Manufacturer's Materials and Workmanship Warranty: 20 year NDL (No Dollar Limit).

B. Installer's Warranty: Two years on DFCM form.

1.5 MATERIALS

A. PVC Membrane Roofing: ASTM D 4434, Type IV, fabric-reinforced and fabric-backed PVC sheet.

1. Thickness: 80 mils.
2. Color: White.

B. Low VOC adhesives and sealants for LEED.

C. Sheet Flashing: Same as PVC sheet membrane.

D. Substrate Board: Glass-mat, water-resistant gypsum board.

E. Roof Insulation: Polyisocyanurate board.

1. Tapered Boards: 1/4 inch per 12 inches where slope can not be achieved with deck slope.

F. Cover Board: Glass-mat, water-resistant gypsum substrate.

1.6 INSTALLATION

A. Roof Insulation: Mechanically fastened and adhered.

B. Membrane Roofing: Adhered.

C. Membrane Roofing joints: Heat Sealed

1.7 FIELD QUALITY CONTROL

A. Testing Agency: Owner engaged.

END OF SECTION 07542

SECTION 07543 - THERMOPLASTIC POLYOLEFIN (TPO) ROOFING

1.1 SUMMARY

A. Adhered or Mechanically fastened TPO membrane roofing system.

B. Vapor retarder.

C. Roof insulation.

1.2 PERFORMANCE REQUIREMENTS

A. Roofing System Design: Uplift pressures calculated according to ASCE/SEI 7.

B. FM Approvals Listing: Class 1A-90.

1.3 QUALITY ASSURANCE

A. Exterior Fire-Test Exposure: Class B.

B. Preinstallation conference.

1.4 WARRANTY

A. Manufacturer's Materials and Workmanship Warranty: 30 year NDL (no dollar limit) warranty.

B. Installer's Warranty: Two years on DFCM form.

1.5 MATERIALS

A. TPO Membrane Roofing: ASTM D 6878, internally fabric or scrim reinforced, uniform, flexible TPO sheet.

1. Thickness: 80 mils, nominal.
2. Color: White.

B. Sheet Flashing: Same as TPO sheet membrane.

C. Substrate Board: Glass-mat, water-resistant gypsum board.

D. Vapor Retarder: Per manufacturers recommendation.

E. Roof Insulation: Polyisocyanurate board.

1. Tapered Boards: 1/4 inch per 12 inches.

F. Cover Board: Glass-mat, water-resistant gypsum substrate or wood fiber board, as recommended by Manufacturer.

G. Walkways: Pads.

1.6 INSTALLATION

A. Roof Insulation: Adhered or Mechanically fastened. Install in two layers with staggered joints.

B. Membrane Roofing: Adhered or Mechanically fastened.

1.7 FIELD QUALITY CONTROL

A. Testing Agency: Owner engaged.

END OF SECTION 07543

SECTION 07620 - SHEET METAL FLASHING AND TRIM

1.1 SUMMARY

A. Formed Low-Slope Roof Flashing and Trim and Soffit:

1. Copings.
2. Gable end trim
3. Soffits

1.2 PERFORMANCE REQUIREMENTS

A. Copings: Capable of resisting Wind Zone 3 forces according to FMG Loss Prevention Data Sheet 1-49.

1.3 QUALITY ASSURANCE

A. Quality Standard: SMACNA's "Architectural Sheet Metal Manual."

1.4 MATERIALS

A. Sheet Metals for Flashing and Trim:

1. Prepainted, Metallic-Coated Steel or Aluminum: High-performance organic.

B. Underlayment: Ice and Water Shield.

END OF SECTION 07620

SECTION 07720 - ROOF ACCESSORIES

1.1 SUMMARY

A. Roof hatches.

1.2 QUALITY ASSURANCE

A. Sheet Metal Standard: SMACNA's "Architectural Sheet Metal Manual."

1.3 WARRANTY

A. Special Warranty on Painted Finishes: 15 years from date of Substantial Completion.

1.4 PRODUCTS

A. Roof Hatches: Prepainted, metallic-coated steel.

1.5 FABRICATION

A. Connections: Welded.

END OF SECTION 07720

SECTION 07841 - THROUGH-PENETRATION FIRESTOP SYSTEMS

1.1 SUMMARY

A. Through-penetration firestop systems for penetrations through fire-resistance-rated fire walls fire partitions fire barriers smoke barriers floors floor/ceiling assemblies and ceiling membranes of roof/ceiling assemblies.

1.2 PERFORMANCE REQUIREMENTS

A. Provide through-penetration firestop systems with the following ratings determined per ASTM E 814 or UL 1479:

1. F-Rated Systems: F-ratings equaling or exceeding fire-resistance rating of constructions penetrated.
2. T-Rated Systems: For penetrations located outside wall cavities and outside fire-resistance-rated shaft enclosures.
3. L-Rated Systems: Where through-penetration firestop systems are indicated in smoke barriers.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: A firm approved by FMG according to FMG 4991, "Approval of Firestop Contractors."

B. Fire-Test-Response Characteristics: Tested per ASTM E 814 by UL.

1.4 MATERIALS

A. Accessories: Permanent forming/damming/backing materials substrate primers collars and steel sleeves as needed to comply with performance requirements.

1.5 INSTALLATION

A. Identification: Preprinted metal or plastic labels, permanently attached.

1.6 FIELD QUALITY CONTROL

A. Inspection of Installed Firestop Systems: By Owner-engaged agency according to ASTM E 2174 requirements.

END OF SECTION 07841

SECTION 07920 - JOINT SEALANTS

1.1 SUMMARY

A. Exterior Joints in Vertical Surfaces and Horizontal Nontraffic Surfaces:

1. Control and expansion joints in unit masonry.
2. Joints between different materials listed above.
3. Perimeter joints around frames of doors windows.

B. Exterior Joints in Horizontal Traffic Surfaces:

1. Isolation and contraction joints in cast-in-place concrete slabs.
2. Joints between different materials listed above.

C. Interior Joints in Vertical Surfaces and Horizontal Nontraffic Surfaces:

1. Control and expansion joints on exposed interior surfaces of exterior walls.
2. Perimeter joints of exterior openings.
3. Control and expansion and inside corner joints in tile.
4. Vertical joints on exposed surfaces of interior unit masonry walls.
5. Perimeter joints between interior wall surfaces and frames of interior doors windows.
6. Joints between plumbing fixtures and adjoining walls, floors, and counters.

D. Interior Joints in Horizontal Traffic Surfaces:

1. Isolation joints in cast-in-place concrete slabs.

1.2 WARRANTY

A. Installer: Two years.

B. Manufacturer: Ten years.

1.3 MATERIALS

A. Elastomeric Joint Sealants: Liquid applied, chemically curing; ASTM C 920.

1. Pourable neutral-curing silicone sealants.
2. Nonsag neutral-curing silicone sealants.
3. Acid-curing silicone sealants.
4. Mildew-resistant neutral-curing silicone sealants.
5. Nonsag and Pourable urethane sealants.

B. Latex Joint Sealants: ASTM C 834, Type P, Grade NF.

C. Acoustical Joint Sealants: Latex.

D. Preformed Tape Sealants: Back-bedding mastic, butyl based.

E. Joint-Sealant Backing: Cylindrical Closed Cell Elastomeric tubing.

END OF SECTION 07920

SECTION 08110 - STEEL DOORS AND FRAMES

1.1 SUMMARY

A. Standard hollow metal doors and frames.

1.2 QUALITY ASSURANCE

A. Standard Hollow Metal Quality Standard: ANSI/SDI A250.8.

1.3 PRODUCTS

A. Standard Hollow Metal Doors:

1. Design: Flush panel.
2. Thermal-Rated Doors: Exterior.
3. Exterior Doors: 16 ga. Galvanized steel sheet faces.

a. Model: 1 (Full Flush)
b. Tob of Door: Provide closed top design sealed against water intrusion.

4. Interior Doors: 18 ga. cold-rolled steel sheet faces.

a. Model: 1 (Full Flush).

B. Standard Hollow Metal Frames:

1. Exterior Frames: Galvanized steel sheet; face welded.

a. 14 ga thick steel sheet.
b. Rigid insulation

2. Interior Frames: Cold-rolled steel sheet; face welded.

a. 16 ga thick steel sheet up to 4 foot opening, 14 ga. over 4 foot.

C. Finishes: Factory priming for field painting.

1.4 INSTALLATION

A. Concrete and Masonry Walls: Frames filled with grout.

END OF SECTION 08110

SECTION
08211 - FLUSH WOOD DOORS

1.1 QUALITY ASSURANCE

A. Quality Standard: AWI.

1. AWI Quality Certification Labels or an AWI letter of licensing for doors.

B. Fire-Rated Wood Doors: Comply with IBC for pressure testing.

1.2 DOOR CONSTRUCTION, GENERAL

A. Low-Emitting Materials: Made with adhesives and composite wood products that do not contain urea formaldehyde.

1.3 VENEERED-FACED DOORS FOR TRANSPARENT FINISH

A. Exterior Solid-Core Doors Not acceptable

B. Interior Solid-Core Doors:

1. Grade: Premium, with Grade A faces .
2. Species: Red oak is the minimum.
3. Cut: Plain sliced (flat sliced), Quarter sliced, or Rift cut. Rotary cut is unacceptable.
4. Match between Veneer Leaves: Book; Slip or Pleasing match.
5. Assembly of Veneer Leaves on Door Faces: Balance match.
6. Edge: Matching veneer
7. Special Matching:

a. Pair and set match.
b. Room Match: Door faces of compatible color and grain within each room.

8. Core: Particleboard.
9. Construction: Five or seven plies, bonded.

C. Hollow-Core Doors are Not acceptable:

1.4 LOUVERS AND LIGHT FRAMES

A. Louvers: Not acceptable.

B. Light-Opening Frames:

1. Metal.

1.5 PRIMING/FINISHING

A. Factory Finishing: All doors.

B. Transparent Factory Finishes:

1. Grade: Premium.
2. Finish: Catalyzed polyurethane.
3. Effect: Semifilled finish.

END OF SECTION 08211

SECTION 08311 - ACCESS DOORS AND FRAMES

1.1 SUMMARY

A. Access doors and frames for walls and ceilings.

B. Floor access doors and frames.

1.2 QUALITY ASSURANCE

A. Fire-Rated Vertical Access Doors and Frames: NFPA 252 or UL 10B.

B. Fire-Rated Horizontal Access Doors and Frames: ASTM E 119 or UL 263.

1.3 PRODUCTS

A. Access Doors and Frames for Walls and Ceilings:

1. Type:

   a. Flush access doors and frames with exposed trim.
   b. Fire-rated, insulated, flush access doors and frames with exposed trim.

2. Material: Steel (except in restroom wall installations); Stainless steel (in restrooms if mounted in tile).
3. Fire-Resistance Rating: As required to match wall or ceiling rating..
4. Latch: Self-latching bolt operated by keyed cylinder with interior release.

B. Finishes:

1. Steel: Primed finish.
2. Stainless Steel: Directional satin, No. 4 finish.

END OF SECTION 08311

SECTION 08411 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

1.1 SUMMARY

A. Exterior storefront framing.

B. Exterior manual-swing entrance doors and door-frame units.

1.2 PERFORMANCE REQUIREMENTS

A. Structural Performance:

1. Wind Loads: 20 psf.

1.3 MAINTENANCE SERVICE

A. Entrance Door Hardware: Twelve months.

1.4 MATERIALS

A. Aluminum: Alloy and temper recommended by manufacturer.

B. Steel reinforcement.

1.5 FRAMING SYSTEMS

A. Framing Members: Manufacturer's standard extruded-aluminum framing members.

1. Construction: Thermally broken.

B. Brackets and reinforcements.

C. Fasteners and accessories.

D. Concrete and masonry inserts.

E. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing

F. Framing system gaskets and sealants.

1.6 GLAZING SYSTEMS

A. Glazing: As specified in Division 8 Section "Glazing."

B. Glazing gaskets.

C. Spacers and setting blocks.

D. Bond-breaker tape.

E. Glazing Sealants:

1. Weatherseal sealant.

1.7 ENTRANCE DOOR SYSTEMS

A. Entrance Doors:

1. Door Construction: 1-3/4-inch overall thickness.
2. Door Design: medium stile rails with 10" bottom rail and 5" top rail.
3. Glazing stops and gaskets.

B. Entrance Door Hardware:

1. Hinges: continuous heavy Duty gear hinges- Roton or equal.
2. Exit device: Snow College prefers Von Duprin.
3. Closer: Snow College prefers LCN- provide closer with hold open function, and “cush-n-stop” function.
4. Provide electric operator at main entry to comply with DFCM enhanced accessibility.
5. Stainless steel kick plate

1.8 ALUMINUM FINISHES

A. Aluminum Finishes: Class II, clear or color anodic.

1.9 SOURCE QUALITY CONTROL

A. Structural-Sealant-Glazed Systems: Tested and inspected according to ASTM C 1401 recommendations.

END OF SECTION 08411

SECTION 08520 - ALUMINUM WINDOWS

1.1 PERFORMANCE REQUIREMENTS

A. Engineering design of aluminum windows by Contractor.

B. Basic Wind Speed: 90 mph.

1.2 QUALITY ASSURANCE

A. Quality Standard: AAMA/WDMA 101/I.S.2/NAFS.

1.3 WINDOWS

A. Type: Fixed and operable thermal break construction

B. Sub Sill: Provide aluminum sub sill with vertical legs turned up at the back and ends and with all joints sealed to shed water to the outside of the building.

C. U-Factor: 0.43 Btu/sq. ft. x h x deg F or less.

D. Solar Heat-Gain Coefficient: Whole-window SHGC maximum of 0.50.

E. Glazing: Site glazed.

1. Glass: See Glazing Section.
2. Glazing System: Manufacturer's standard.

F. Finishes: Class I, clear or color anodic.

END OF SECTION 08520

SECTION 08710 - DOOR HARDWARE

1.1 SUMMARY

A. Commercial door hardware for swinging and sliding doors.

1.2 MAINTENANCE SERVICE

A. Full-Maintenance Service: Twelve months.

1.3 PRODUCTS

A. Hinges:

1. Aluminum Doors: Gear type extruded aluminum heavy duty anodize to match window system
2. Interior: Brass or Steel, exposed ball bearing type
3. Fire-Rated Assemblies: Steel or stainless steel, exposed ball bearing type
4. Options: maximum security pin on outswinging exterior doors and nonremovable pins on outswinging corridor doors.

B. Mechanical Locks and Latches: Best 9K levers with no matching or exceeding grade.

C. Auxiliary Locks and Latches: Grade 1.

D. Electronic locks: Electronic locks; consisting of complete lockset, motor-driven lock mechanism, and actuating device. Provide key override.

1. Schlage AD 300 wired system
2. Magnetic-stripe card reader, must be compatible with Snow College card system
3. Trim: Match trim specified for mechanical locks.
4. Accessories: Computer, card encoder, software, training, 500 extra cards, all associated accessories including power transfer hinges, power supplies, repeaters, etc, etc, etc to provide a complete operating system.

E. Door Bolts:

1. Dustproof Strikes: Grade 1.

F. Exit Devices: Von Duprin 99/98; 33 series for narrow stile door..

1. 2 piece dead locking latch bolts rate to 2,000+lbs. static load force..
2. Strikes to incorporate a roller to reduce wear.
3. All devices must incorporate hydraulic sound damper
4. Outside Trim: Match locksets and latchsets.

G. Cylinders and Keying:

1. Cylinders: **Schlage Everest B124 series Small Format Interchangeable Core** keyed to existing system- Contractor to coordinate with Snow College. Snow College will provide a bitting chart.

    a. Grade 1.
    b. Restricted Keyway.
    c. Number of Pins: Seven.
    d. Cores: Interchangeable.

2. Construction Keying: Construction cores.
3. Keying System:

    a. Great-grand master key.
    b. Locks master keyed or grand master keyed to existing system.
    c. All cylinders keyed alike.
    d. Keys: Nickel silver.

H. Key-Control System:

1. Cabinet: Grade 1, wall mounted.
2. Index System: Multiple index, computer software.

I. Key lock boxes.

J. Operating Trim: Stainless steel.

K. ADA Operators: LCN 4640 series.

1. Use at exterior entries, and public restroom doors.

L. Closers: LCN

1. Surface: Grade 1.
2. Closer holder release devices.
3. Coordinators- rectangular units mounted at frame head- full width of opening Glynn Johnson COR or similar.

M. Protective Trim Units: Stainless steel.

N. Stops at all doors.

O. Silencers for metal door frames w/o smoke seals.

P. Door Gasketing: As required for rating and acoustics.

Q. Finishes: US 26D, (except for kick plates, mop plates, armor plates, push and pull which will all be 32D).

1.4 FIELD QUALITY CONTROL

A. Occupancy Adjustment: Twelve months.

END OF SECTION 08710

SECTION 08800 - GLAZING

1.1 SUMMARY

A. Glazing required for the following:

1. Windows.
2. Doors.
3. Glazed entrances.
4. Interior borrowed lites.
5. Storefront framing.

1.2 WARRANTY

A. Deterioration of Coated Glass: Not less than 10 years.

B. Deterioration of Insulating Glass: Not less than 10 years.

C. Availability of glass: 50 year guarantee of availability of matching glass for future replacement.

1.3 MATERIALS

A. Glass Products:

1. Annealed Float Glass: Clear and Tinted.
2. Heat-Treated Float Glass: fully tempered.
3. Coated Float Glass: Pyrolytically or Sputter coated.
4. Fire rated safety glazing: Laminated ceramic glass.
5. Insulating Glass: Manufacturer's standard dual-seal units.

B. Silicone Glazing Sealants: Neutral or basic curing, Class 25.

C. Glazing Tapes: Back-bedding-mastic type.

D. Glazing Gaskets: Dense compression.

1.4 GLASS UNITS

A. Monolithic Float-Glass Units:

1. 6 mm clear

B. Insulating-Glass Units:

1. Tinted outer 6 mm lite, ½" air space, 6mm clear inner lite with low E coating on 3rd surface.

END OF SECTION 08800

SECTION 08911 - GLAZED ALUMINUM CURTAIN WALLS

1.1 SUMMARY

A. Conventionally glazed aluminum curtain walls installed as stick or unitized systems.

1.2 QUALITY ASSURANCE

A. Contractor to engineer glazed aluminum curtain-wall systems to comply with performance requirements.

1.3 WARRANTY

A. Assembly Warranty: 10 years- including leakage through sealants or gaskets.

1.4 COMPONENTS

A. Framing Systems: Aluminum with steel reinforcement (if required).

B. Sub Sill: Provide aluminum sub sill with vertical legs turned up at the back and ends and with all joints sealed to shed water to the outside of the building.

C. Glazing Systems:

1. Glazing: Specified in Division 8 Section "Glazing."
2. Gaskets: Pressure-glazing system.
3. Glazing Sealants: As recommended by manufacturer.

D. Aluminum Finishes: Class II, clear or color anodic.

1.5 FABRICATION

A. Provisions for field replacement of glazing from exterior.

END OF SECTION 08911

SECTION 09111 - NON-LOAD-BEARING STEEL FRAMING

1.1 SUMMARY

A. Non-load-bearing steel framing members for interior framing and suspension systems.

1.2 MATERIALS

A. Suspension Systems:

1. Wire hangers.
2. Flat hangers.
3. Carrying channels.
4. Furring channels.
5. Grid suspension systems for ceilings.

B. Steel Framing for Framed Assemblies:

1. Interior studs and runners: minimum 3 5/8" x 20 ga. Space studs at 16" O.C.
2. Exterior studs- gauge and depth as required for wind and seismic loads- however space studs at 24" O.C. to reduce insulation derating because of thermal bridging.
3. Studs at door jambs: 16 ga. studs to structure or cross bracing.
4. Slip-Type Head Joints:

    a. Single long-leg runner.
    b. Double runner.
    c. Deflection track.

5. Firestop track.
6. Flat strap and backing plate.
7. Cold-rolled channel bridging.
8. Hat-shaped, rigid furring channels.
9. Resilient furring channels.
10. Cold-rolled furring channels.
11. Z-shaped furring.

END OF SECTION 09111

SECTION 09250 - GYPSUM BOARD

1.1 SUMMARY

A. Interior gypsum board.

1.2 MATERIALS

A. Interior Gypsum Board: Minimum 5/8" thick.

1. Regular type.
2. Type X.
3. Ceiling Type: Manufactured to have more sag resistance than regular-type gypsum board.
4. Moisture- and mold-resistant type.
5. Abuse resistant panels, USG Fiberock or equal, VHI (very high impact) for all walls in community type areas and hallways.

B. Trim Accessories:

1. Metal only- no plastic. Provide muddable types only, where exposed to view- no “J” mold is acceptable in exposed areas.

1.3 INSTALLATION

A. Install gypsum board vertically unless the space is a two story high area.

B. In areas with oblique lighting- i.e. corridors with a window at the end, lobby walls that end at windows, etc., provide level 5 finish.

C. All exposed areas, except those above, provide a level 4 finish.

D. Knockdown texture may be acceptable on ceilings, verify with Snow College. Walls to have no texture.

END OF SECTION 09250

SECTION 09310 - CERAMIC TILE

1.1 SUMMARY

A. Ceramic mosaic, paver, glazed wall and special-purpose tile.

B. Stone thresholds installed as part of tile installations.

C. Crack-suppression membrane for thin-set tile installations.

D. Metal edge strips installed as part of tile installations.

1.2 MATERIALS

A. Glazed Wall Tile Trim Shapes: Coved base Straight base Surface bullnose cap Bullnose external corner.

B. Ceramic Mosaic Trim Shapes: Coved base.

C. Thresholds: Marble w/ double bevel.

D. Crack-Suppression Membranes: Chlorinated polyethylene sheet PVC sheet Polyethylene sheet Corrugated polyethylene Fabric-reinforced, modified-bituminous sheet Fabric-reinforced, fluid-applied rubber Urethane waterproofing and tile-setting adhesive.

E. Elastomeric Sealants: One-part, mildew-resistant silicone.

1.3 FLOOR TILE INSTALLATION SCHEDULE

A. Interior Floors on Crack-Suppression/Waterproof Membrane over Concrete: Thin-set mortar over setting bed. Provide 1 ½" recess in slab for setting bed.

1. Tile Type: 2" x2" unglazed ceramic mosaic tile- color groups 1 & 2.
2. Mortar: Latex- portland cement mortar bond coat.
3. Grout: Polymer-modified sanded grout- seal joints with “Aquamix” penetrating sealer.

1.4 WALL TILE INSTALLATION SCHEDULE

A. Interior Walls over Gypsum Board on Metal Studs: Organic adhesive.

1. Tile Type: Glazed wall tile- in restrooms, all wall shall be tile floor to ceiling.
2. Grout: Polymer-modified unsanded grout.

END OF SECTION 09310

SECTION 09511 - ACOUSTICAL PANEL CEILINGS

1.1 SUMMARY

A. Acoustical panels and exposed suspension systems.

B. System engineered for seismic resistance.

1.2 QUALITY ASSURANCE

A. Acoustical Panel Quality Standard: ASTM E 1264.

B. Metal Suspension System Quality Standard: ASTM C 635.

1.3 MATERIALS

A. Acoustical Ceiling Panels:

1. Type and Form: Type III, mineral base with painted finish; Form 2, water felted.
2. Pattern: E (lightly textured) or G (smooth).
3. LR: Not less than 0.90.
4. NRC: Not less than 0.70.
5. CAC: Not less than 25.
6. Thickness: 3/4 inch.
7. Modular Size: 24 by 24 inches with reveal (tegular) edge.

B. Metal Suspension Systems:

1. Wire hangers, braces, and ties.
2. Hanger rods.
3. Angle hangers.
4. Seismic perimeter stabilizer bars, struts, and clips.
5. Wide-Face, Capped, Double-Web Steel: Heavy duty.

C. Metal Edge Moldings and Trim: “3/4" engineered system with seismic clip connection.

D. Acoustical sealants.

1.4 INSTALLATION

A. Installation: Comply with CISCA requirements.

END OF SECTION 09511

SECTION 09651 - RESILIENT FLOOR TILE

1.1 PRODUCTS

A. Vinyl Composition Floor Tile:

1. Class: Through pattern.
2. Wearing Surface: Smooth.
3. Thickness: 0.125 inch.
4. Size: 12 by 12 inches.

B. Installation Materials:

1. Trowelable leveling and patching compounds.
2. Adhesives.
3. Seamless-installation accessories.
4. Floor polish- match Snow College's standard.

1.2 FLOOR TILE INSTALLATION

A. Lay tiles in pattern indicated-checkerboard recommended.

END OF SECTION 09651

SECTION 09653 - RESILIENT WALL BASE AND ACCESSORIES

1.1 PRODUCTS

A. Resilient Base: Only for hard surface floors.

1. Type (Material Requirement): TS (rubber, vulcanized thermoset).
2. Group (Manufacturing Method): I (solid).
3. Style: Cove (with top-set toe) for vinyl tile and sealed concrete
4. Minimum Thickness: 0.125 inch.
5. Height: 4 inches.
6. Lengths: Coils in manufacturer's standard length.
7. Outside Corners: Job formed.
8. Inside Corners: Job formed.
9. Surface: Smooth.

B. Resilient Molding Accessory: Rubber.

1. Transition strips.
2. Stair treads.
3. Stair risers.
4. Stair skirting.

C. Installation Materials:

1. Trowelable leveling and patching compounds.
2. Adhesives.

END OF SECTION 09653

SECTION 09681 - CARPET TILE

1.1 SUMMARY

A. Carpet tile- all carpeted areas.

1.2 MATERIALS

A. Carpet Tile: (State Contract- Snow College Standard) Subject to compliance with requirements, provide one of the following in a 28 oz weight:

1. Collins and Aikman
2. Milliken
3. Shaw/Stratton

1.3 INSTALLATION

A. Installation Method: Glue down with releasable adhesive.

END OF SECTION 09681

SECTION 09912 - INTERIOR PAINTING

1.1 SUMMARY

A. Surface preparation and the application of paint systems on interior substrates.

1.2 QUALITY ASSURANCE

A. Quality Standards: "MPI Approved Products List" and "MPI Architectural Painting Specification Manual."

B. Mockups for each color and finish.

1.3 INTERIOR PAINTING SCHEDULE

A. CMU Substrates:

1. One coat latex block filler, two coats acrylic enamel.

B. Steel Substrates:

1. One coat primer, one coat undercoater, top coat alkyd enamel.

C. Galvanized-Metal Substrates: (roof deck)

1. Water-Based Dry-Fall System: MPI INT 5.3H.

D. Gypsum Board Substrates:

1. 2 coats acrylic enamel over primer, coordinate gloss with Snow College.

END OF SECTION 09912

SECTION 10431 - SIGNAGE

1.1 SUMMARY

A. Panel signs, provide signs for all doors in the building.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable provisions in ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.

1.3 WARRANTY

A. Materials and Workmanship: Five years.

1.4 PRODUCTS

A. Panel Signs:

1. Interior Panel Signs:

a. Material: Coordinate with Snow College sign standard.
b. Mounting: Wall with concealed anchors- tape or adhesive not allowed.
c. Color: As selected by Architect from manufacturer's full range.

1.5 INSTALLATION

A. Wall-Mounted Signs: Concealed mechanical fasteners.

END OF SECTION 10431

SECTION 10522 - FIRE EXTINGUISHER CABINETS

1.1 PRODUCTS

A. Fire Protection Cabinet:

1. Type: For 10# fire extinguisher.
2. Construction: Nonrated or 1-hour fire rated, or 2-hour fire rated- coordinate with wall type.
3. Mounting: Semirecessed.
4. Door Style: Vertical duo panel with frame Center glass panel with frame.
5. Door Glazing: Tempered break glass.
6. Accessories: Door locks, battery operated tamper alarm.
7. Finish: Door and Frame: Baked enamel or powder coated steel.
8. Body: Steel, baked enamel or powder coated.

END OF SECTION 10522

SECTION 10523 - FIRE EXTINGUISHERS

1.1 SUMMARY

A. Hand-carried fire extinguishers.

1.2 QUALITY ASSURANCE

A. Fire Extinguishers: NFPA 10.

1.3 WARRANTY

A. Materials and Workmanship: Six years.

1.4 PRODUCTS

A. Portable, Hand-Carried Fire Extinguishers:

1. 4A60BC (10#)Multipurpose dry-chemical type, manufacturer's standard container with chrome plated brass valve (aluminum not acceptable).

B. Mounting Brackets: Galvanized steel with identification lettering.

END OF SECTION 10523

SECTION 10801 - TOILET AND BATH ACCESSORIES

1.1 SUMMARY

A. Public-Use Washroom Accessories:

1. Toilet Tissue Dispenser: Not in Contract- vendor supplied.
2. Paper Towel Dispenser: Not in Contract- vendor supplied.
3. Waste Receptacle: Owner supplied garbage can.
4. Liquid-soap dispenser: Not in Contract- vendor supplied.
5. Grab bar: Stainless Steel, concealed fastners
6. Vendor: Sanitary napkin and tampon, Stainless Steel, Semi-recessed, coin operation.
7. Sanitary-napkin disposal unit: Stainless Steel
8. Mirror unit: Stainless Steel frame.

B. Underlavatory guards. (If using wall mounted sinks)

C. Custodial Accessories:

1. Stainless Steel Mop and broom holder with shelf.

1.2 WARRANTY

A. Silver Spoilage for Mirrors: 15 years.

END OF SECTION 10801

SECTION 12491 - HORIZONTAL LOUVER BLINDS

1.1 SUMMARY

A. Horizontal louver blinds with polymer slats.

1.2 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: Passes NFPA 701.

B. Mockups for each form of construction.

1.3 PRODUCTS

A. Horizontal Louver Blinds, Aluminum Slats:

1. Nominal Slat Width: 2 inch.
2. Coating: Antistatic.
3. Tilt Control: Manual with wand.
4. Lift Operation: [Manual with cord.
5. Valance.

1.4 INSTALLATION

A. Mounting: Head.

END OF SECTION 12491

SECTION 14240 - HYDRAULIC ELEVATORS

1.1 SUMMARY

A. Hydraulic passenger elevators.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: ASME A17.1.

1. Effective Peak Velocity Acceleration (Av): 0.20 or more (seismic risk zones 3 and 4).

1.3 WARRANTY

A. Elevator Work: One year.

1.4 MAINTENANCE SERVICE

A. Full Maintenance Service: One year. Also, if elevator manufacturer utilizes timers or cycle counts to disable the elevator, this function shall be turned off and the manufacturer shall provide the Owner with the bypass code.

1.5 COMPONENTS

A. Pump Units: Mounted on oil tank in steel enclosure or submersible pump, suspended inside tank.

1. Motor: Solid-state starting- 480V 3 Phase- verify with Snow College.

B. Hydraulic Fluid: Biodegradable and fire resistant.

C. Seismic Protection: Pump unit and hoistway rails shall be anchored per IBC zone 3 requirements.

D. Signal Equipment:

1. Car Control Stations: Recessed one per car.
2. Emergency communication system.
3. Firefighters' two-way telephone communication service.

E. Elevator Description:

1. Cylinder Type: Holeless, telescoping, beside the car.
2. Rated Load: 2500 lb.
3. Rated Speed: 125 fpm minimum.
4. Operation System: Group automatic.
5. Auxiliary Operations:

a. Battery-powered lowering.
b. Automatic dispatching of loaded car.
c. Nuisance call cancel.
d. Independent service for all cars in group.
e. Loaded-car bypass.

6. Inside Width: 80 inches.
7. Inside Depth: 51 inches.
8. Inside Height: 94 inches.
9. Front Walls (Return Panels): Stainless steel.
10. Side and Rear Wall Panels: Plastic laminate.
11. Doors: Textured stainless steel.
12. Ceiling: Luminous ceiling.
13. Handrails: Stainless steel.
14. Threshold: Aluminum.
15. Floor: Prepared to receive carpet.

16. Hoistway Entrances:

a. Width: 42 inches.
b. Height: 84 inches.
c. Type: Single-speed side sliding.
d. Frames Stainless steel.
e. Doors Textured stainless steel.
f. Threshold: Aluminum.

17. Hall Fixtures Stainless steel.

END OF SECTION 14240

SECTION 15010 - GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 GENERAL

A. General Conditions and Division 01 apply to this Division.

1.2 SCOPE

A. Includes -

1. Furnish all labor, materials, and equipment necessary for the completion of the mechanical and plumbing scope of work.
2. Furnish and install all motors specified in this Division and be responsible for the proper operation of electrical powered equipment furnished by this Division.
3. Furnish exact location of electrical connections and information on motor controls to Division 16.
4. Mechanical Contractor shall obtain the services of independent Test and Balance Agency.
5. Placing the air conditioning, heating, ventilating, and exhaust systems into full operation and continuing their operation during each working day of testing and balancing.
6. Making changes in pulleys, belts, and dampers, or adding dampers, as required for the correct balance as recommended by Balancing Contractor at no additional cost to Owner.
7. Air balance, final adjustment and test run.
8. The satisfactory performance of the completed systems is a requirement of this specification.
9. Design build mechanical contractor and engineer shall follow all SUU's design and construction standards found on their web site.

B. Related Work Specified Elsewhere

1. Conduit, line voltage wiring, outlets, and disconnect switches specified in Division 16.
2. Magnetic starters and thermal protective devices (heaters) not a factory mounted integral part of packaged equipment are specified in Division 16.

1.3 SITE OBSERVATION

A. The Contractor should examine the site and understand the existing conditions and site utilities which may affect the performance of work of this Division. Contractor must familiarize himself with the campus roads, parking restrictions staging areas and campus safety regulations during construction.

B. No subsequent allowance for time or money will be considered for any consequence related to failure to examine existing site conditions.

1.4 DRAWINGS

A. Mechanical drawings shall show general arrangement of piping, ductwork, equipment, etc; follow as closely as actual building construction and work of other trades will permit.

B. Because of the small scale of mechanical drawings, it is not possible to indicate all offsets, fittings, and accessories which may be required. Become familiar with new structural and finished conditions affecting this work and arrange work accordingly, providing such fittings, valves, and accessories required to meet conditions.

C. If changes in location of piping, equipment, ducts, etc. are required due to lack of coordination of work under this division, such changes shall be made without charge. Contractor shall review drawings with the university and DFCM and any changes required by them shall be completed prior to commencement of work.

1.5 CODE REQUIREMENTS, FEES, AND PERMITS

A. The work shall be installed in accordance with the following applicable codes, ordinances and standards unless otherwise specified. The codes and standards shall include but not be limited to and be of the latest and current editions.

1. American Boiler and Affiliated Industries (AB and AI)
2. American Gas Association (AGA)
3. Air Movement and Control Association (AMCA)
4. American National Standards Institute (ANSI)
5. Air Conditioning & Refrigeration Institute (ARI)
6. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) - ASHRAE 90.1-2004
7. American Society of Mechanical Engineers (ASME)
8. American Society of Testing Materials (ASTM)
9. American Standards Association (ASA)
10. American Water Works Association (AWWA)
11. American Welding Society (AWS)
12. Associated Air Balance Council (AABC)
13. Heat Exchange Institute (HEI)
14. Snow College Design Standards
15. DFCM Standards
16. National Electrical Code (NEC)

17. National Fire Protection Association (NFPA)
18. Sheet Metal and Air Conditioning contractors National Association (SMACNA)
19. Underwriters Laboratories (UL)
20. International Building Code (IBC) 2009 Ed
21. International Mechanical Code (IMC) 2009 Ed
22. International Plumbing Code (IPC) with Utah Amendments 2009 Ed\
23. International Energy Conservation Code (IECC) 2009 Ed
24. Utah State Safety Orders (OSHA/UOSH)
25. Utah Fire Rating Bureau
26. Utah Boiler and Pressure Vessel Law
27. Utah Air Conservation Regulations/Waste Disposal regulations.
28. ASHRAE Ventilation STD.62-2007

B. Should drawings conflict with any code, the code shall govern. If drawings and specifications establish a quality exceeding the code, the drawings and specifications shall govern. Contractor shall comply with applicable codes.

C. The latest edition of all codes shall be used.

D. Contractor shall give all notices, obtain all necessary permits, file necessary plans, prepare documents and obtain approvals, and pay all fees required for completion of the mechanical and plumbing work outlined in this Division of the specifications and shown on the Mechanical Drawings.

1.6 OPERATION AND MAINTENANCE MANUAL FOR MECHANICAL SYSTEMS

A. Upon completion of work and before final payment, Contractor shall furnish and deliver to the Owner, through the Architect and General Contractor, installation, operation and maintenance manuals with instructions for all new materials and equipment used in the building. The contractor shall provide three (3) hard copies of the manuals, and three (3) CD's with electronic copies of the manuals. Electronic information shall be .PDF format. The CD's shall include the same information as the hard copies, and shall be organized in the same manner with electronic bookmarks for each section. CD case and the CD itself shall be labeled the same as the hard copies of the manuals.

B. Bind Operation and Maintenance Manual for Mechanical Systems in a hard-backed piano hinge loose-leaf binder with strong sturdy cover. The project name shall be on the spine and the front of the binder. The front of the binder shall include the following information:

OPERATION
AND
MAINTENANCE
MANUAL
for MECHANICAL SYSTEMS of
(Name of Project)
(Location of Project)
(Date of Project Award)

C. Introduction

1. Title page including name of project, project number, date awarded and date of substantial completion.
2. Second page shall contain the names, phone numbers and addresses of Architect and Consulting Engineers. General Contractor Mechanical Contractor.
3. Third page shall include a Table of Contents for the entire manual.

D. First Section - Summary information including:

1. First page shall contain the contractor's warranties.
2. Second page shall contain a list of names, addresses and phone numbers of contractors and all sub-contractors and work to which each was assigned.
3. Final page or pages shall contain an equipment list. The list shall contain each item of equipment or material for which a submittal was required giving ID or tag no as contained on the drawings make and model No. Serial No. Identification No. Location in building, function along with the name, address, and phone number of the supplier.

E. Second Section - Mechanical Equipment O&M data including:

1. Mechanical maintenance schedule, including a lubrication list when necessary.
2. Mechanical Equipment Operation and Maintenance Data including:

    a. Equipment descriptions
    b. Detailed installation instruction, operating and maintenance instructions. Instructions include in a step by step manner identifying start-up, operating, shutdown and emergency action sequence sufficiently clear so a person unfamiliar with the equipment could perform its operations.
    c. Equipment drawings, performance curves, operating characteristics, etc.
    d. Name addresses and phone number of manufacturer, fabricator and local vender clearly printed or stamped on cover.
    e. Complete parts listing which include catalog number, serial number, contract number or other accurate provision for ordering replacement and spare parts.
    f. Certified drawings, where applicable, showing assembly of parts and general dimensions.

3. Approved Mechanical submittals

F. Third Section - Plumbing Equipment O&M data including:

1. Section shall contain general product catalog cuts, as well as exploded view drawings with parts lists for all valves and other items with multiple parts.
2. Approved Plumbing submittals

G. Fourth Section - Controls O&M data including:

1. Sequence of Operation
2. Description of each operating system included location of switches, breakers, thermostats, and control devices. Provide a single line diagram, showing set points, normal operating parameters for all loads, pressures, temperatures and flow check points; Describe all alarms and cautions for operation.
3. Provide schematic control diagrams, panel diagrams, wiring diagrams, etc. for each separate fan system, chilled water system, hot water system, exhaust air system, pumps, etc. Each control diagram shall show a schematic representation of mechanical equipment and location of start-stop switches, insertion thermostats, thermometers, pressure gauges, automatic valves, etc. The correct reading for each control instrument shall be marked on the diagram.

H. The Fifth Section shall contain a complete air and water test and balance report. The report shall contain the name, address and phone number of the agency. It shall also include:

1. Floor plans showing all air openings and thermometer locations clearly marked and cross referenced with data sheets. Format may be 8 1/2 x 11 or 11x14 if legible.
2. Data sheets showing amount of air and water at each setting. See sections 15950.
3. List of equipment with date of last calibration.

I. Drawings and reproducible masters of drawings as required in individual specification sections, are not to be bound in volumes but are to be delivered separate with the maintenance manuals.

J. See the following checklist for assistance in assembling manual:

Item #	Description	Y, N, or NA
1.	3 ring heavy duty binder with Project name, number and date on cover and project name on spine.	
2.	O&M manual on CD (with label on CD matching label on manual). Electronic copy shall be a PDF file with bookmarks that match the tabs in the hard copy.	
3.	Title Page [including project name, number, address, date awarded, date of substantial completion]	
4.	Second Page Contact List [including architect (if applicable), mechanical engineer, mechanical contractor, and general contractor (if applicable)]	
5.	Table of Contents	
6.	Section 1 - Summary	
A.	Warranty	
B.	Mechanical's Sub-contractor List	
C.	Vendor List	
D.	Equipment List	
7.	Section 2 – Mechanical Equipment	

A.	Maintenance Schedule (including lubrication list)	
B.	Mechanical Equipment O&M Data (for each piece of equipment submitted) per specifications	
C.	Approved mechanical submittals	
8.	Section 3 – Plumbing Equipment	
A.	Plumbing equipment O&M data	
B.	Approved plumbing submittals	
9.	Section 4 - Controls	
A.	Sequence of Operation	
B.	Controls diagrams	
C.	Controls Equipment	
10.	Section 5 – Test and Balance Report	
A.	Complete Test and Balance Report per specifications	

1.7 OPERATION AND MAINTENANCE INSTRUCTIONS

A. Contractor shall instruct building maintenance personnel in the operation and maintenance of the installed mechanical systems utilizing the Operation and Maintenance Manual when so doing.

B. Minimum instruction periods shall be six hours

C. Instruction periods shall occur before final site observation when systems are properly working and before final payment is made.

D. An additional two hours of instruction will be provided by each contractor, after 60 days of system operation by owner to insure proper system operation and to answer questions.

1.8 RECORD DRAWINGS

A. Contractor shall keep an up-to-date set of mechanical and plumbing drawings in his custody showing all changes in red, clearly defined and neatly drafted by him. At the end of construction, he shall turn these drawings over to the Owner. Record drawings must be completed and submitted prior to final site observation

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PART 2 - PRODUCTS
(Not Used)

PART 3 - EXECUTION

(Not Used)

END OF SECTION 15010

SECTION 15050 - BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Transition fittings.
3. Dielectric fittings.
4. Mechanical sleeve seals.
5. Sleeves.
6. Escutcheons.
7. Grout.
8. Equipment installation requirements common to equipment sections.
9. Touchup Painting and finishing.
10. Concrete bases.
11. Supports and anchorages.

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, crawlspaces, 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.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:

1. ABS: Acrylonitrile-butadiene-styrene plastic.

2. CPVC: Chlorinated polyvinyl chloride plastic.
3. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Dielectric fittings.
2. Mechanical sleeve seals.
3. Sleeves.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

B. All materials, piping, etc. shall be new, and domestically made of the best commercial quality obtainable, consistent with specified materials and for the purpose or function intended unless specifically approved in writing prior to bid.

1.6 DELIVERY, STORAGE, AND HANDLING

A. 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.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

C. Project flanges, fittings and piping specialties from moisture and dirt.

1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for mechanical items requiring access that are concealed behind finished surfaces.

D. Coordinate connection of mechanical and plumbing systems with exterior underground utilities.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 15 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 15 piping Sections for special joining materials not listed below.

B. 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 thickness or specific material is indicated.

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.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

G. Solvent Cements for Joining Plastic Piping:

1. ABS Piping: ASTM D 2235.
2. CPVC Piping: ASTM F 493.
3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
4. PVC to ABS Piping Transition: ASTM D 3138.

2.4 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

1. Available Manufacturers:

a. Cascade Waterworks Mfg. Co.
b. Dresser Industries, Inc.; DMD Div.
c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
d. JCM Industries.
e. Smith-Blair, Inc.
f. Viking Johnson.
g. Prior Approved Equal.

2. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.
3. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.
4. Aboveground Pressure Piping: Pipe fitting.

B. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

1. Available Manufacturers:

a. Cascade Waterworks Mfg. Co.
b. Fernco, Inc.
c. Mission Rubber Company.
d. Plastic Oddities, Inc.
e. Prior Approved Equal.

2.5 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

1. Available Manufacturers:

a. Capitol Manufacturing Co.
b. Central Plastics Company.
c. Eclipse, Inc.
d. Epco Sales, Inc.
e. Hart Industries, International, Inc.
f. Watts Industries, Inc.; Water Products Div.
g. Zurn Industries, Inc.; Wilkins Div.
h. Prior Approved Equal.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

1. Available Manufacturers:

a. Capitol Manufacturing Co.
b. Central Plastics Company.
c. Epco Sales, Inc.
d. Watts Industries, Inc.; Water Products Div.
e. Prior Approved Equal.

E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

1. Available Manufacturers:

a. Calpico, Inc.
b. Lochinvar Corp.
c. Prior Approved Equal.

F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

1. Available Manufacturers:

a. Perfection Corp.
b. Precision Plumbing Products, Inc.
c. Sioux Chief Manufacturing Co., Inc.
d. Victaulic Co. of America.
e. Prior Approved Equal.

2.6 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Available Manufacturers:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Metraflex Co.
d. Pipeline Seal and Insulator, Inc.
e. Linkseal.
f. Prior Approved Equal.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Carbon steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

2.8 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.

2.9 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.

3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 15 Sections specifying piping systems.

B. Drawings shall indicate general location and arrangement of piping systems. Drawings do not have to show every offset, or bend that may be required. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install all piping at right angles and parallel to building walls. Diagonal runs are prohibited.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections. Notching of piping or bending of pipe to form fitting is not allowed.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Provide and install escutcheons for penetrations of walls, ceilings, and floors any other location where penetrating will be visible to public.

M. Provide and install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

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. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is provided.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint.

N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.

Q. Verify final equipment locations for roughing-in.

R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 15 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. 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.

E. 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.

F. 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.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. Plastic 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. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
5. PVC Nonpressure Piping: Join according to ASTM D 2855.
6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.

J. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

3.3 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.5 PAINTING

A. Painting of mechanical systems, equipment, and components is specified in Division 9.

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.6 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.7 GROUTING

A. Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION 15050

SECTION 15055 - MOTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes basic requirements for factory installed motors.

1.3 DEFINITIONS

A. Factory-Installed Motor: A motor installed by motorized-equipment manufacturer as a component of equipment.

1.4 SUBMITTALS

A. Provide with equipment.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain field-installed motors through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices and features that comply with the following:

1. Compatible with the following:

a. Magnetic controllers.
b. Multispeed controllers.
c. Reduced-voltage controllers.

2. Designed and labeled for use with variable frequency controllers, and suitable for use throughout speed range without overheating.
3. Matched to torque and horsepower requirements of the load.
4. Matched to ratings and characteristics of supply circuit and required control sequence.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

PART 2 - PRODUCTS

2.1 MOTOR REQUIREMENTS

A. Motor requirements apply to factory installed motors except as follows:

1. Different ratings, performance, or characteristics for motor are specified in another Section.
2. Motorized-equipment manufacturer requires ratings, performance, or characteristics, other than those specified in this Section, to meet performance specified.

2.2 MOTOR CHARACTERISTICS

A. Motors 1 HP and Larger: Three phase.

B. Motors Smaller Than 1 HP: Single phase.

C. Frequency Rating: 60 Hz.

D. Voltage Rating: NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected.

E. Service Factor: 1.15 for open dripproof motors; 1.0 for totally enclosed motors.

F. Duty: Continuous duty at ambient temperature of 105 deg F and at altitude of 5800 feet above sea level.

G. 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.

H. Enclosure: Open dripproof indoors and totally enclosed on exterior.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Premium, as defined in NEMA MG 1.

C. Stator: Copper windings.

1. Multispeed motors shall have separate winding for each speed.

D. Rotor: Squirrel cage, unless otherwise indicated.

E. Bearings: Double-shielded, prelubricated ball bearings suitable for radial and thrust loading.

F. Temperature Rise: Match insulation rating, unless otherwise indicated.

G. Insulation: Class F, unless otherwise indicated.

H. 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.

I. Enclosure: Cast iron for motors 7.5 hp and larger; rolled steel for motors smaller than 7.5 hp.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Designed with critical vibration frequencies outside operating range of controller output.
2. Temperature Rise: Matched to rating for Class B insulation.
3. Insulation: Class H.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.5 SINGLE-PHASE MOTORS

A. Type: One of the following, to suit starting torque and requirements of specific motor application:

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

B. Shaded-Pole Motors: For motors 1/20 hp and smaller only.

C. 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.

D. Bearings: Ball type for belt-connected motors and other motors with high radial forces on motor shaft; sealed, prelubricated-sleeve type for other single-phase motors.

E. Source Quality Control for Field-Installed Motors: Perform the following tests on each motor according to NEMA MG 1:

1. Measure winding resistance.
2. Read no-load current and speed at rated voltage and frequency.
3. Measure locked rotor current at rated frequency.
4. Perform high-potential test.

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION 15055

SECTION 15060 - HANGERS AND SUPPORTS FOR MECHANICAL 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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following hangers and supports for mechanical system piping and equipment:

1. Steel pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Equipment supports.

B. Related Sections include the following:
1. Division 15 Section "Vibration and Seismic Controls for Piping and Equipment" for vibration isolation devices.

1.3 DEFINITIONS

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

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Design seismic-restraint hangers and supports for piping and equipment.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Steel pipe hangers and supports.
2. Thermal-hanger shield inserts.
3. Powder-actuated fastener systems.
4. Pipe positioning systems.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."

B. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."
2. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Manufacturers:

1. AAA Technology & Specialties Co., Inc.
2. B-Line Systems, Inc.; a division of Cooper Industries.
3. Carpenter & Paterson, Inc.
4. Empire Industries, Inc.
5. Grinnell Corp.
6. GS Metals Corp.
7. National Pipe Hanger Corporation.
8. Piping Technology & Products, Inc.
9. Prior approved equal.

2.3 TRAPEZE PIPE HANGERS

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

2.4 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Manufacturers:

1. B-Line Systems, Inc.; a division of Cooper Industries.
2. GS Metals Corp.
3. Grinnel Corp.
4. Thomas & Betts Corporation.
5. Unistrut Corp.
6. Prior approved equal.

C. Coatings: Manufacturer's standard finish.

2.5 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Manufacturers:

1. Carpenter & Paterson, Inc.
2. Pipe Shields, Inc.
3. Rilco Manufacturing Company, Inc.
4. Value Engineered Products, Inc.
5. Prior approved equal.

C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with vapor barrier.

D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate.

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

F. For Clevis Hangers: Insert and shield shall cover lower 180 degrees of pipe.

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

2.6 FASTENER SYSTEMS

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

1. Manufacturers:

a. Hilti, Inc.
b. ITW Ramset/Red Head.
c. Masterset Fastening Systems, Inc.
d. MKT Fastening, LLC.
e. Powers Fasteners.
f. Prior approved equal.

2.7 EQUIPMENT SUPPORTS

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

2.8 MISCELLANEOUS MATERIALS

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

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified 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 nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

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

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
2. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.

3. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
4. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
5. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
6. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
7. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
8. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
9. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
10. 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.

E. 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 20.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

F. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
2. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.

G. 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.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.

7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
10. 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.

11. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

H. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
2. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

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

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.

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

K. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

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

3.2 HANGER AND SUPPORT INSTALLATION

A. Steel 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 building structure.

B. 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 above for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

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

D. 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.

E. "Plumbing Fixtures" for plumbing fixtures.

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

G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

H. 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 bends, and similar units.

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

J. 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.

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

L. Pipe Slopes: Install hangers and supports to provide pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.

M. Insulated Piping: Comply with the following:

1. Attach clamps and spacers to piping.

a. Piping Operating above and below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.

b. Do not exceed pipe stress limits according to ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 40, protective shields on piping. Shields shall span an arc of 180 degrees.

3. 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.

4. Insert Material: Length at least as long as protective shield.
5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 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 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 contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe after insulation.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 9

END OF SECTION 15061

SECTION 15074 - VIBRATION AND SEISMIC CONTROLS 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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Isolation pads.
2. Isolation mounts.
3. Freestanding and restrained spring isolators.
4. Housed spring mounts.
5. Spring hangers.
6. Spring hangers with vertical-limit stops.
7. Pipe riser resilient supports.
8. Resilient pipe guides.
9. Seismic snubbers.
10. Restraining braces and cables.

1.3 DEFINITIONS

A. IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

1.4 PERFORMANCE REQUIREMENTS

A. Wind-Restraint Loading:

1. Basic Wind Speed: Per owner's design standards.
2. Building Classification Category: As defined in the IBC.
3. Minimum 10 lb/sq. ft. multiplied by the maximum area of the HVAC component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.

B. Seismic-Restraint Loading:

1. Site Class: As defined in the IBC.
2. Assigned Seismic Use Group or Building Category: As defined in the IBC.

a. Component Importance Factor: 1.0.

1.5 SUBMITTALS

A. Product Data: For the following:

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 seismic-restraint component used.

   a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.
   b. Annotate to indicate application of each product submitted and compliance with requirements.

3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Letter of Design intent, stating company, design criteria, compliance with specifications and only exceptions that will apply. Letter shall be stamped and signed by a licensed and qualified professional engineer in this jurisdiction.

C. Delegated-Design Submittal: For vibration isolation and seismic-restraint details 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. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic and wind forces required to select vibration isolators, seismic and wind restraints, and for designing vibration isolation bases.

   a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Division 22 and 23 Sections for equipment mounted outdoors.

2. 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 has been examined for excessive stress and that none will exist.
3. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.
4. Seismic- and Wind-Restraint Details:

   a. Design Analysis: To support selection and arrangement of seismic and wind 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 spacing's. 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. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Division 15 Sections for equipment mounted outdoors.
d. Preapproval and Evaluation Documentation: By an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (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: 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.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

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

1. Amber/Booth Company, Inc.
2. Kinetics Noise Control.
3. Mason Industries.
4. Vibration Eliminator Co., Inc.
5. Prior approved equal.

B. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.

1. Resilient Material: Oil- and water-resistant neoprene or rubber.

C. Mounts: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.

1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

D. Restrained Mounts: All-directional mountings with seismic restraint.

1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

E. Spring Isolators: Freestanding, laterally stable, open-spring isolators.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

F. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Restraint: Seismic or limit stop as required for equipment and authorities having jurisdiction.

3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

G. Housed Spring Mounts: Housed spring isolator with integral seismic snubbers.

1. Housing: Ductile-iron or steel housing to provide all-directional seismic restraint.
2. Base: Factory drilled for bolting to structure.
3. Snubbers: Vertically adjustable to allow a maximum of 1/4-inch travel up or down before contacting a resilient collar.

H. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

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

I. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch- thick neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig and for equal resistance in all directions.

J. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch- thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.2 VIBRATION ISOLATION EQUIPMENT BASES

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

1. Amber/Booth Company, Inc.

2. Kinetics Noise Control.
3. Mason Industries.
4. Vibration Eliminator Co., Inc.
5. Prior approved equal.

B. Steel Base: Factory-fabricated, welded, structural-steel bases and rails.

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 and discharge elbows 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.

2.3 SEISMIC-RESTRAINT DEVICES

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

1. Amber/Booth Company, Inc.
2. Hilti, Inc.
3. Kinetics Noise Control.
4. Mason Industries.
5. Unistrut; Tyco International, Ltd.
6. Prior approved equal.

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
3. Maximum 1/4-inch air gap, and minimum 1/4-inch- thick resilient cushion.

D. Channel Support System: MFMA-3, shop- or field-fabricated support 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; and rated in tension, compression, and torsion forces.

E. Restraint Cables: -steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.

F. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or Reinforcing steel angle clamped to hanger rod.

G. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

H. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

I. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

J. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

K. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.4 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.
2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
3. Baked enamel or powder coat for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation and seismic- and wind-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic- and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

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 evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Comply with requirements in Division 7 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

B. Equipment Restraints:

1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
3. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction providing required submittals for component.

C. Piping Restraints:

1. Comply with requirements in MSS SP-127.
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.

D. Install cables so they do not bend across edges of adjacent equipment or building structure.

E. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction providing required submittals for component.

F. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

G. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

H. 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.

I. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

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 Division 15 Section "Hydronic Piping" for piping flexible connections.

3.5 FIELD QUALITY CONTROL

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

B. Perform tests and inspections.

C. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. Verify snubber minimum clearances.
9. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.6 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 15074

SECTION 15075 - MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following mechanical identification materials and their installation:

1. Equipment nameplates.
2. Equipment signs.
3. Access panel and door markers.
4. Pipe markers.
5. Valve tags.
6. Valve schedules.

1.3 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping. Colors of piping in Mechanical rooms shall match university color code.

1.4 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with location of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES

A. Equipment Nameplates: Equipment manufacturer shall provide metal, nameplates, with data engraved or stamped, for permanent attachment on equipment.

1. Data:

    a. Manufacturer, product name, model number, and serial number.
    b. Capacity, operating and power characteristics, and essential data.
    c. Labels of tested compliances.

2. Location: Accessible and visible.
3. Fasteners: As required to mount on equipment. Adhesive is not acceptable.

B. Equipment Signs: Provided by contractor. ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.

1. Data: Equipment name and number, capacity, HP ie pump P-1, 100 gpm @ 50ft. ad 5hp.
2. Engraving: Manufacturer's standard letter style, 1/4” or larger with terms to match equipment identification.
3. Thickness: 1/8 inch, unless otherwise indicated.
4. Fasteners: Self-tapping, stainless-steel screws.

C. Access Panel and Door Markers: Provide 1 1/16” thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification. Provide 1/8” center hole for attachment.

1. Fasteners: Self-tapping, stainless-steel screws.

2.2 PIPING IDENTIFICATION DEVICES

A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.

1. Colors: Comply with SUU color standards and ASME A13.1, if color standards are not available.
2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
3. Pipes with OD, Including Insulation, Less Than 6 Inches: Provide full-band pipe markers extending 360 degrees around pipe at each location.
4. Pipes with OD, Including Insulation, 6 Inches and Larger: Provide either full-band or strip-type pipe markers at least three times letter height and of length required for label.
5. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.

B. Self-Adhesive Pipe Markers: Plastic with pressure-sensitive, permanent-type, self-adhesive back.

2.3 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers, with numbering scheme approved by Engineer. Provide 5/32-inch hole for fastener.

1. Material: 0.032-inch- thick brass.
2. Valve-Tag Fasteners: Brass wire-link or beaded chain; or S-hook.

2.4 VALVE SCHEDULES

A. Valve Schedules: For each piping system, on standard-size 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.

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

A. Products specified are for applications referenced in other Division 15 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 EQUIPMENT IDENTIFICATION

A. Equipment manufacturer shall install and permanently fasten equipment nameplates on each major item of mechanical equipment. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:

1. Fuel-burning units, including boilers, heaters, etc.
2. Pumps, compressors, chillers, condensers, and similar motor-driven units.
3. Heat exchangers, coils, evaporators, and similar equipment.
4. Fans and blowers.
5. Packaged fan coil units.

B. Install equipment signs with screws on or near each major item of mechanical equipment listed above and below. Locate signs where accessible and visible.

1. Identify mechanical equipment with black equipment markers with white lettering.
2. Letter Size: Minimum 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.
3. Data: Distinguish among multiple units, indicate operational requirements, GPM, HD, CFM, S.P., HP and identify units.

4. Include signs for the following general categories of equipment:

    a. Fuel-burning units, including boilers, heaters, etc.
    b. Pumps, compressors, chillers, condensers, and similar motor-driven units.
    c. Heat exchangers, coils, evaporators, and similar equipment.
    d. Fans and blowers.
    e. Packaged fan coil units.
    f. Tanks and pressure vessels.

C. Install access panel markers with screws on equipment access panels.

3.3 PIPING IDENTIFICATION

A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.

B. Locate pipe markers and color bands where piping is exposed in finished spaces; mechanical rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; 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 nonaccessible enclosures.
4. At access doors, 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 markers.

3.4 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves. 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:

1. Valve-Tag Size:

    a. Cold Water: 1-1/2 inches.
    b. Hot Water: 1-1/2 inches.
    c. Gas: 1-1/2 inches.
    d. Steam: 2 inches.

2. Letter Color:

a. Depression black filled numbers not less than ½" high and black filled letters not less than ¼" high.

3.5 VALVE-SCHEDULE INSTALLATION

A. Mount valve schedule on wall in accessible location in each major equipment room.

3.6 ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.7 CLEANING

A. Clean faces of mechanical identification devices and glass frames of valve schedules.

END OF SECTION 15075

SECTION 15080 - HVAC AND PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Insulation Materials:

a. Calcium silicate.
b. Mineral fiber.

2. Fire-rated insulation systems.
3. Insulating cements.
4. Adhesives.
5. Lagging adhesives.
6. Factory-applied jackets.
7. Field-applied jackets.
8. Tapes.
9. Securements.
10. Corner angles.

B. Related Sections:

1. Division 15 Section "Metal Ducts" for duct liners.

1.3 SUBMITTALS

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

B. Qualification Data: For qualified Installer.

1.4 QUALITY ASSURANCE

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

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per 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 and inspecting agency.

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

1.5 DELIVERY, STORAGE, AND HANDLING

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

1.6 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 15 Section "Hangers and Supports."

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

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in Part 3 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. Calcium Silicate:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Industrial Insulation Group (The); Thermo-12 Gold.
   b. Prior approved equal.

2. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
3. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
4. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

E. 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 I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. CertainTeed Corp.; Duct Wrap.
   b. Johns Manville; Microlite.
   c. Knauf Insulation; Duct Wrap.
   d. Manson Insulation Inc.; Alley Wrap.
   e. Owens Corning; All-Service Duct Wrap.
   f. Prior approved equal.

F. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Fibrex Insulations Inc.; Coreplus 1200.
   b. Johns Manville; Micro-Lok.
   c. Knauf Insulation; 1000 Pipe Insulation.
   d. Manson Insulation Inc.; Alley-K.
   e. Owens Corning; Fiberglas Pipe Insulation.
   f. Prior approved equal.

2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Insulco, Division of MFS, Inc.; Triple I.
b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.
c. Prior approved equal.

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. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-97.
b. Foster Products Corporation, H. B. Fuller Company; 81-27/81-93.
c. Marathon Industries, Inc.; 290.
d. Mon-Eco Industries, Inc.; 22-30.
e. Vimasco Corporation; 760.
f. Prior approved equal.

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

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-82.
b. Foster Products Corporation, H. B. Fuller Company; 85-20.
c. ITW TACC, Division of Illinois Tool Works; S-90/80.
d. Marathon Industries, Inc.; 225.
e. Mon-Eco Industries, Inc.; 22-25.
f. Prior approved equal.

D. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Dow Chemical Company (The); 739, Dow Silicone.
b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
c. P.I.C. Plastics, Inc.; Welding Adhesive.
d. Red Devil, Inc.; Celulon Ultra Clear.
e. Speedline Corporation; Speedline Vinyl Adhesive.
f. Prior approved equal.

2.4 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Childers Products, Division of ITW; CP-52.
    b. Foster Products Corporation, H. B. Fuller Company; 81-42.
    c. Marathon Industries, Inc.; 130.
    d. Mon-Eco Industries, Inc.; 11-30.
    e. Vimasco Corporation; 136.
    f. Prior approved equal.

2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation.
3. Service Temperature Range: Minus 50 to plus 180 deg F.
4. Color: White.

2.5 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

2.6 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. Products: Subject to compliance with requirements, provide one of the following:

    a. Johns Manville; Zeston.
    b. P.I.C. Plastics, Inc.; FG Series.
    c. Proto PVC Corporation; LoSmoke.
    d. Speedline Corporation; SmokeSafe.
    e. Prior approved equal.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: Color-code jackets based on system. Color as selected by Architect.
4. 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.

5. Factory-fabricated tank heads and tank side panels.

C. Metal Jacket:

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Childers Products, Division of ITW; Metal Jacketing Systems.
   b. PABCO Metals Corporation; Surefit.
   c. RPR Products, Inc.; Insul-Mate.
   d. Prior approved equal.

2. 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.
   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.
      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.

2.7 TAPES

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

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
   b. Compac Corp.; 104 and 105.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
   d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
   e. Prior approved equal.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
   b. Compac Corp.; 110 and 111.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
   d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
   e. Prior approved equal.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
   b. Compac Corp.; 130.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
   d. Venture Tape; 1506 CW NS.
   e. Prior approved equal.

2. Width: 2 inches.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
   b. Compac Corp.; 120.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
   d. Venture Tape; 3520 CW.
   e. Prior approved equal.

2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

2.8 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products; Bands.
b. PABCO Metals Corporation; Bands.
c. RPR Products, Inc.; Bands.
d. Prior approved equal.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide.

2.9 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 and other conditions affecting performance of insulation application.

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

3.2 PREPARATION

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

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Mix insulating cements with clean potable 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, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, and 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 when looking up and bottom when looking down 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 as recommended by insulation material manufacturer to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and 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 Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. 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.

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

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

1. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems."

3.5 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

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 aluminum stainless steel, at least 0.040 inch 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.

3.6 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, and Flanges.

1. Install insulation over fittings, valves, strainers, flanges, 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 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 and flanges. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

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

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

1. Make removable flange insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange covers are made from sectional pipe insulation, extend insulation from flanges 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.

3.7 CALCIUM SILICATE INSULATION INSTALLATION

A. Insulation Installation on Tanks:

1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation material.
2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.
3. On exposed applications without metal jacket, finish insulation surface with a skim coat of mineral-fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth. Thin finish coat to achieve smooth, uniform finish.

B. Insulation Installation on Straight Pipes and Tubes:

1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.
2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.
3. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.

C. 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 cut sections of block insulation of same material and thickness as pipe insulation.
4. Finish flange insulation same as pipe insulation.

D. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.
3. Finish fittings insulation same as pipe insulation.

E. Insulation Installation on Valves and Pipe Specialties:

1. Install mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
2. Install insulation to flanges as specified for flange insulation application.
3. Finish valve and specialty insulation same as pipe insulation.

3.8 MINERAL-FIBER INSULATION INSTALLATION

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 but 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.

3.9 FIRE-RATED INSULATION SYSTEM INSTALLATION

A. Install firestopping at penetrations through fire-rated assemblies.

3.10 FIELD QUALITY CONTROL

A. Tests and Inspections:

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

3.11 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Fresh air, low pressure, round or rectangular duct insulation shall be the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

3.12 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 in paragraphs below that is not factory insulated.

C. Chillers: Insulate cold surfaces on chillers, including, but not limited to, evaporator bundles, condenser bundles, suction piping, compressor inlets, tube sheets, water boxes, and nozzles with one of the following:

1. Mineral-Fiber Pipe and Tank: 1 inch thick.

D. Steam-to-hot-water converter insulation shall be one of the following:

1. Calcium Silicate: 3 inches thick.
2. Mineral Fiber: 2 inches thick.

E. Chilled-water pump insulation shall be one of the following:

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

F. Heating-hot-water pump insulation shall be one of the following:

1. Calcium Silicate: 3 inches thick.
2. Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density.

G. Chilled-water expansion tank insulation shall be one of the following:

1. Mineral-Fiber Pipe and Tank: 2 inch thick.

H. Heating-hot-water expansion tank insulation shall be one of the following:

1. Mineral fiber: 2 inches thinck.

I. Chilled-water air-separator insulation shall be one of the following:

1. Calcium Silicate - 2 inches thick.
2. Mineral-Fiber Pipe and Tank: 2 inches thick.

J. Heating-hot-water air-separator insulation shall be one of the following:

1. Calcium Silicate: 3 inches thick.
2. Mineral Fiber: 2 inches thick.

3.13 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. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

C. Piping System insulation:

1. Hydronic Piping - Mineral Fiber, per chart.
2. Domestic Water Piping -Mineral Fiber, per chart.
3. Horizontal Roof Drain Piping - Mineral Fiber, 1/2".
4. Steam Piping - Mineral Fiber, per chart.

3.14 INDOOR PIPING INSULATION SCHEDULE

A. Minimum Pipe Insulation Thickness from ANSI/ASHRAE/IESNA Standard 90.1-2007

Fluid Design Operating Temp. Range (°F)	Insulation Conductivity		Nominal				
	Conductivity Btu•in./(h•ft^2• F)	Mean Rating Temp. °F	<1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8
Heating Systems (Steam, Steam Condensate, and Hot Water)							
>350	0.32-0.34	250	2.5	3.0	3.0	4.0	4.0
251-350	0.29-0.32	200	1.5	3.0	3.0	3.0	3.0
201-250	0.27-0.30	150	1.5	1.5	2.0	2.0	2.0
141-200	0.25-0.29	125	1.0	1.0	2.0	2.0	2.0
105-140	0.22-0.28	100	0.5	0.5	1.0	1.0	1.0
Domestic and Service Hot Water Systems							
105+	0.22-0.28	100	0.5	0.5	1.0	1.0	1.0
Cooling Systems (Chilled Water, Brine, and Refrigerant)							
40-60	0.22-0.28	100	0.5	1.0	1.5	1.5	1.5
<40	0.22-0.28	100	0.5	1.0	1.5	1.5	1.5

3.15 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, Exposed:

1. PVC: 20 mils thick.

3.16 OUTDOOR, 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. Exterior piping, Exposed:

1. Aluminum jacket.

END OF SECTION 15083

SECTION 15110 - VALVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following general-duty valves:

1. Copper-alloy ball valves.
2. Ferrous-alloy ball valves.
3. Ferrous-alloy butterfly valves.
4. Bronze check valves.
5. Gray-iron swing check valves.
6. Ferrous-alloy wafer check valves.
7. Bronze gate valves.
8. Cast-iron gate valves.
9. Bronze globe valves.
10. Cast-iron globe valves.
11. Chainwheel actuators.

B. Related Sections include the following:

1. Division 2 piping Sections for general-duty and specialty valves for site construction piping.
2. Division 13 fire-suppression piping and fire pump Sections for fire-protection valves.
3. Division 15 Section "Mechanical Identification" for valve tags and charts.
4. Division 15 Section "HVAC Instrumentation and Controls" for control valves and actuators.
5. Division 15 piping Sections for specialty valves applicable to those Sections only.

1.3 DEFINITIONS

A. The following are standard abbreviations for valves:

1. CWP: Cold working pressure.
2. EPDM: Ethylene-propylene-diene terpolymer rubber.
3. NBR: Acrylonitrile-butadiene rubber.
4. PTFE: Polytetrafluoroethylene plastic.
5. SWP: Steam working pressure.
6. TFE: Tetrafluoroethylene plastic.

1.4 SUBMITTALS

A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

1.5 QUALITY ASSURANCE

A. ASME Compliance: ASME B31.9 for building services piping valves.

B. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.

C. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.6 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, and globe valves closed to prevent rattling.
4. Set ball valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 VALVES, GENERAL

A. Refer to Part 3 "Valve Applications" Article for applications of valves.

B. Bronze Valves: NPS 2 and smaller with threaded ends, unless otherwise indicated.

C. Ferrous Valves: NPS 2-1/2 and larger with flanged ends, unless otherwise indicated.

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

E. Valve Sizes: Same as upstream pipe, unless otherwise indicated.

F. Valve Actuators:

1. Chainwheel: For attachment to valves, of size and mounting height, as indicated in the "Valve Installation" Article in Part 3.
2. Handwheel: For valves other than quarter-turn types.
3. Lever Handle: For quarter-turn valves NPS 6 and smaller, except plug valves.

G. Extended Valve Stems: On insulated valves.

H. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.

I. Valve Grooved Ends: AWWA C606.

1. Threaded: With threads according to ASME B1.20.1.

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

2.3 VALVE TYPES TO MANUFACTURERS:

A. Refer to Snow College Standards.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.

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

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

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

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

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

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

3.2 VALVE APPLICATIONS

A. Refer to piping Sections for specific valve applications. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball, butterfly, or gate valves (steam only).
2. Throttling Service: Ball or butterfly valves.
3. Pump Discharge: Spring-loaded, lift-disc check valves.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.

C. Chilled-Water Piping: Use the following types of valves:

1. Ball Valves, NPS 2 and Smaller: Two-piece, 400-psig CWP rating, copper alloy.
2. Ball Valves, NPS 2-1/2 and Larger: Class 150, ferrous alloy.
3. Butterfly Valves, NPS 2-1/2 and Larger: Flangeless Flanged, 150-psig CWP rating, ferrous alloy, with EPDM liner.
4. Grooved-End, Ductile-Iron Butterfly Valves, NPS 2-1/2 and Larger: 175-psig CWP rating.
5. Swing Check Valves, NPS 2 and Smaller: Type 4, Class 125, bronze.
6. Swing Check Valves, NPS 2-1/2 and Larger: Type II, Class 125, gray iron.
7. Wafer Check Valves, NPS 2-1/2 and Larger: Dual-plate, wafer, Class 150 ferrous alloy.

D. Domestic Water Piping: Use the following types of valves:

1. Ball Valves, NPS 2 and Smaller: One-piece, copper alloy.
2. Ball Valves, NPS 2-1/2 and Larger: Class 150, ferrous alloy.
3. Swing Check Valves, NPS 2 and Smaller: Type 4, Class 125, bronze.
4. Swing Check Valves, NPS 2-1/2 and Larger: Type II, Class 125, gray iron.

E. Heating Water Piping: Use the following types of valves:

1. Ball Valves, NPS 2 and Smaller: Two-piece, 400-psig CWP rating, copper alloy.
2. Ball Valves, NPS 2-1/2 and Larger: Class 150, ferrous alloy.
3. Butterfly Valves, NPS 2-1/2 and Larger: Flangeless Flanged, 150-psig CWP rating, ferrous alloy, with EPDM liner.

4. Swing Check Valves, NPS 2 and Smaller: Type 4, Class [125] [150] [200], bronze.
5. Swing Check Valves, NPS 2-1/2 and Larger: Type II, Class [125] [250], gray iron.
6. Wafer Check Valves, NPS 2-1/2 and Larger: Dual-plate, wafer, Class 150, ferrous alloy.

F. Low-Pressure Steam Piping: Use the following types of valves:

1. Ball Valves, NPS 2 and Smaller: Three-piece, 400-psig CWP rating, copper alloy.
2. Swing Check Valves, NPS 2 and Smaller: Type 4, Class 150, bronze.
3. Swing Check Valves, NPS 2-1/2 and Larger: Type II, Class 125, gray iron.
4. Gate Valves, NPS 2 and Smaller: Type 2, Class 150, bronze.
5. Gate Valves, NPS 2-1/2 and Larger: Type I, Class 125, NRS, bronze-mounted cast iron.
6. Globe Valves, NPS 2-1/2 and Larger: Type I, Class 125, bronze-mounted cast iron.

G. High-Pressure Steam Piping: Use the following types of valves:

1. Ball Valves, NPS 2 and Smaller: Three-piece, 400-psig CWP rating, copper alloy.
2. Swing Check Valves, NPS 2 and Smaller: Type 4, Class 200, bronze.
3. Swing Check Valves, NPS 2-1/2 and Larger: Type II, Class 250, gray iron
4. Gate Valves, NPS 2 and Smaller: Type , Class 200, bronze.
5. Gate Valves, NPS 2-1/2 and Larger: Type I, Class 250, NRS, bronze-mounted cast iron.
6. Globe Valves, NPS 2 and Smaller: Type 1, Class 200, bronze.
7. Globe Valves, NPS 2-1/2 and Larger: Type I, Class 250, bronze-mounted cast iron.

H. Steam Condensate Piping: Use the following types of valves:

1. Ball Valves, NPS 2 and Smaller: Two-piece, 400-psig CWP rating, copper alloy.
2. Ball Valves, NPS 2-1/2 and Larger: Class 150, ferrous alloy.
3. Swing Check Valves, NPS 2 and Smaller: Type 4, Class 150, bronze.
4. Swing Check Valves, NPS 2-1/2 and Larger: Type II, Class 250, gray iron.
5. Gate Valves, NPS 2 and Smaller: Class 150, bronze.
6. Gate Valves, NPS 2-1/2 and Larger: Type I, Class 125, NRS, bronze-mounted cast iron.
7. Globe Valves, NPS 2 and Smaller: Type 2, Class 150, bronze.
8. Globe Valves, NPS 2-1/2 and Larger: Type I, Class 125, bronze-mounted cast iron.

I. Select valves, except wafer and flangeless 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.
7. For Grooved-End, Chilled water piping Copper Tubing or Steel Piping: Valve ends may be grooved. Do not use for steam or steam condensate piping.

3.3 VALVE INSTALLATION

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

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

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

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

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

F. Install chainwheel operators on valves NPS 4 and larger more than 96 inches above floor. Extend chains to 72 inches above finished floor elevation.

G. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.
2. Dual-Plate Check Valves: In horizontal or vertical position, between flanges.
3. Lift Check Valves: With stem upright and plumb.

3.4 JOINT CONSTRUCTION

A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

B. Grooved Joints: Chilled water only Assemble joints with keyed coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

C. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.5 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.

END OF SECTION 15110

SECTION 15121 - PIPE EXPANSION FITTINGS AND LOOPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following pipe expansion joints and expansion compensation devices for mechanical piping systems:

1. Pipe bends and loops.
2. Alignment guides and anchors.

1.3 DEFINITIONS

A. BR: Butyl rubber.

B. Buna-N: Nitrile rubber.

C. CR: Chlorosulfonated polyethylene synthetic rubber.

D. CSM: Chlorosulfonyl-polyethylene rubber.

E. EPDM: Ethylene-propylene-diene terpolymer rubber.

F. NR: Natural rubber.

G. PTFE: Polytetrafluoroethylene plastic.

1.4 PERFORMANCE REQUIREMENTS

A. Compatibility: Products shall be suitable for piping system fluids, materials, working pressures, and temperatures.

B. Capability: Products shall absorb 200 percent of maximum axial movement between anchors.

1.5 SUBMITTALS

A. Product Data: For each type of pipe expansion joint and alignment guide indicated.

B. Shop Drawings: Signed and sealed by a qualified professional engineer.

1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and bends.
2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
3. Alignment Guide Details: Detail field assembly and attachment to building structure.
4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

C. Product Certificates: For each type of pipe expansion joint, signed by product manufacturer.

D. Welding certificates.

E. Operation and Maintenance Data: For pipe expansion joints to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to the following:

1. Steel Shapes and Plates: AWS D1.1, "Structural Welding Code - Steel."
2. Welding to Piping: ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 ALIGNMENT GUIDES

A. Description: Steel, factory fabricated, with bolted two-section outer cylinder and base for alignment of piping and two-section guiding spider for bolting to pipe.

1. Manufacturers:

a. Adsco Manufacturing, LLC.
b. Advanced Thermal Systems, Inc.
c. Flex-Hose Co., Inc.

d. Flexicraft Industries.
e. Flex-Weld, Inc.
f. Hyspan Precision Products, Inc.
g. Metraflex, Inc.
h. Piping Technology & Products, Inc.
i. Senior Flexonics, Inc.; Pathway Division.
j. Prior approved equal.

2.3 MATERIALS FOR ANCHORS

A. Steel Shapes and Plates: ASTM A 36/A 36M.

B. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel, hex head.

C. Washers: ASTM F 844, steel, plain, flat washers.

D. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, and tension and shear capacities appropriate for application.

1. Stud: Threaded, zinc-coated carbon steel.
2. Expansion Plug: Zinc-coated steel.
3. Washer and Nut: Zinc-coated steel.

E. Chemical Fasteners: Insert-type-stud bonding system anchor for use with hardened portland cement concrete, and tension and shear capacities appropriate for application.

1. Bonding Material: ASTM C 881, Type IV, Grade 3, 2-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
2. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
3. Washer and Nut: Zinc-coated steel.

F. Concrete: Portland cement mix, 3000 psi minimum. Refer to Division 3 Section "Cast-in-Place Concrete" for formwork, reinforcement, and concrete.

G. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink, 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 EXPANSION-JOINT INSTALLATION

A. Install manufactured, nonmetallic expansion joints according to FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."

B. Install expansion joints of sizes matching size of piping in which they are installed.

C. Install alignment guides to allow expansion and to avoid end-loading and torsional stress.

3.2 PIPE BEND AND LOOP INSTALLATION

A. Install pipe bends and loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

B. Attach pipe bends and loops to anchors.

1. Steel Anchors: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
2. Concrete Anchors: Attach by fasteners. Follow fastener manufacturer's written instructions.

3.3 SWING CONNECTIONS

A. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.

B. Connect risers and branch connections to terminal units with at least four pipe fittings, including tee in riser.

C. Connect mains and branch connections to terminal units with at least four pipe fittings, including tee in main.

3.4 ALIGNMENT-GUIDE INSTALLATION

A. Install guides on piping adjoining pipe expansion joints and bends and loops.

B. Attach guides to pipe and secure to building structure.

3.5 ANCHOR INSTALLATION

A. 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.

B. Fabricate and install steel anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and AWS D1.1.

C. Construct concrete anchors of poured-in-place concrete of dimensions indicated and include embedded fasteners.

D. Install pipe anchors according to expansion-joint manufacturer's written instructions if expansion joints or compensators are indicated.

E. Use grout to form flat bearing surfaces for expansion fittings, guides, and anchors installed on or in concrete.

END OF SECTION 15121

SECTION 15126 - 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 1 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.
6. Test-plug kits.
7. Sight flow indicators.

B. Related Sections:

1. Division 2 Section "Water Distribution" for domestic water meters and combined domestic and fire-protection water-service meters outside the building.
2. Division 13 fire-suppression piping Sections for fire-protection pressure gages.

1.3 SUBMITTALS

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

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

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

a. Miljoco Corporation.
b. Trerice, H. O. Co.
c. Weiss Instruments, Inc.
d. Prior approved equal.

2. Standard: ASME B40.200.
3. Case: Cast aluminum; 9-inch nominal size unless otherwise indicated.
4. Case Form: Adjustable angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
7. Window: Glass.
8. Stem: Aluminum and of length to suit installation.

   a. Design for Thermowell Installation: Bare stem.

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

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

2.3 PRESSURE GAGES

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

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

   a. Ashcroft Inc.
   b. Marsh Bellofram.
   c. Miljoco Corporation.

d. Trerice, H. O. Co.
e. Weiss Instruments, Inc.
f. Prior approved equal.

2. Standard: ASME B40.100.
3. Case: Liquid-filled type; cast aluminum or drawn steel; 4 1/2 nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Metal.
11. 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 NPS 1/4, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.

B. Valves: Brass or stainless-steel needle, with NPS 1/4, ASME B1.20.1 pipe threads.

2.5 TEST PLUGS

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

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

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

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

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

H. Install test plugs in piping tees.

I. Install thermometers in the following locations:

1. Inlet and outlet of each water heater.
2. Inlets and outlets of each domestic water heat exchanger.
3. Inlet and outlet of each domestic hot-water storage tank.
4. Inlet and outlet of water chiller.
5. Inlet and outlet of boilers.
6. Inlets and outlets of steam to hot water converter both shell and tube.
7. Inlet and outlet of hot and chilled water coils.

J. Install pressure gages in the following locations:

1. Building water service entrance into building.
2. Inlet and outlet of each pressure-reducing valve.
3. Suction and discharge of each water pump.
4. Inlet and outlet of boilers.
5. Inlet and outlet of chiller.
6. Inlet and outlet of each hot and chilled water coils.
7. Inlets and outlets of steam to hot water converter both shell and tube.

3.2 CONNECTIONS

A. Install gages adjacent to machines and equipment to allow service and maintenance of 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 one of the following:

1. Industrial-style, liquid-in-glass type.
2. Test plug with EPDM self-sealing rubber inserts.

B. Thermometers at inlets and outlets of each domestic water heat exchanger shall be one of the following:

1. Industrial-style, liquid-in-glass type.

2. Test plug with EPDM self-sealing rubber inserts.

C. Thermometers at inlet and outlet of each domestic hot-water storage tank shall be one of the following:
1. Industrial-style, liquid-in-glass type.
2. Test plug with EPDM self-sealing rubber inserts.

D. Thermometers at inlet and outlet of each water chiller shall be one of the following:

1. Industrial-style, liquid-in-glass type.
2. Test plug with EPDM self-sealing rubber inserts.

E. 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 200 deg F.

C. Scale Range for Steam Piping: 20 to 400 deg F.

D. Scale Range for Chilled Water Piping: 0 to 100 deg F.

3.6 PRESSURE-GAGE SCHEDULE

A. Pressure gages at discharge of each water service into building shall be one of the following:

1. Liquid-filled, direct-mounted, metal case.
2. Test plug with EPDM self-sealing rubber inserts.

B. Pressure gages at inlet and outlet of each water pressure-reducing valve shall be one of the following:

1. Liquid-filled, direct-mounted, metal case.
2. Test plug with EPDM self-sealing rubber inserts.

C. Pressure gages at suction and discharge of each domestic water pump, conventor, boilers, chiller, water heater, storage tanks etc. shall be one of the following:

1. Liquid-filled, direct-mounted, metal case.
2. Test plug with EPDM self-sealing rubber inserts.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

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

B. Scale Range for Heating Hot Water Piping: 0 to 200 psi.

C. Scale Range for Chilled Water Piping: 0 to 200 psi.

D. Scale Range for Steam Piping: 0 to 200 psi.

END OF SECTION 15126

SECTION 15140 - 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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Under-building slab and aboveground domestic hot and cold water pipes, tubes, fittings, and specialties inside the building to 5’-0” outside building.
2. Escutcheons.
3. Sleeves and sleeve seals.
4. Wall penetration systems.

B. Related Section:

1. Division 2 Section "Water Distribution" for water-service piping and water meters outside the building from source to the point where water-service piping enters the building.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Domestic water piping and support and installation shall withstand effects of earthquake motions determined according to 2006 IBC.

1.4 SUBMITTALS

A. Product Data: For the following products:

1. Specialty valves.
2. Transition fittings.
3. Dielectric fittings.
4. Water meters.
5. Backflow preventers and vacuum breakers.
6. Escutcheons.
7. Sleeves and sleeve seals.
8. Water penetration systems.

1.5 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 61 for potable domestic water piping and components.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

1. Notify Owner no fewer than 72 hours in advance of proposed interruption of water service.
2. Do not proceed with interruption of water 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 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper for all above water piping.

1. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
2. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.3 PIPING JOINING MATERIALS

A. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

B. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.4 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Coupling: AWWA C219.

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

a. Dresser, Inc.; Dresser Piping Specialties.
b. Cascade Waterworks Manufacturing.
c. JCM Industries.
d. Viking Johnson; c/o Mueller Co.
e. Prior approved equal.

2.5 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.

B. Dielectric Unions:

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

a. Capitol Manufacturing Company.
b. Central Plastics Company.
c. EPCO Sales, Inc.
d. Hart Industries International, Inc.
e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
f. Zurn Plumbing Products Group; Wilkins Water Control Products.
g. Prior approved equal.

2. Description:

a. Pressure Rating: 150 psig at 180 deg F.
b. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

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

a. Capitol Manufacturing Company.
b. Central Plastics Company.
c. EPCO Sales, Inc.
d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
e. Prior approved equal.

2. Description:

a. Factory-fabricated, bolted, companion-flange assembly.
b. Pressure Rating: 150 psig.
c. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

2.6 ESCUTCHEONS

A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.

B. One Piece, Cast Brass: Polished, chrome-plated finish with setscrews.

C. One Piece, Deep Pattern: Deep-drawn, box-shaped brass with chrome-plated finish.

D. One Piece, Stamped Steel: Chrome-plated finish with setscrew or spring clips.

E. Split Casting, Cast Brass: Polished, chrome-plated finish with concealed hinge and setscrew.

F. Split Plate, Stamped Steel: Chrome-plated finish with concealed hinge, setscrew or spring clips.

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

H. Split-Casting Floor Plates: Cast brass with concealed hinge.

2.7 SLEEVES

A. Cast-Iron Wall Pipes: Fabricated of cast iron, and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

C. Molded-PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

D. Molded-PVC Sleeves: Permanent, with nailing flange for attaching to wooden forms.

E. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

F. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc-coated, with plain ends.

2.8 SLEEVE SEALS

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

1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex, Inc.
4. Pipeline Seal and Insulator, Inc.
5. Prior approved equal.

B. Description: Modular sealing element unit, designed for field assembly, used to fill annular space between pipe and sleeve.

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

2.9 GROUT

A. Standard: ASTM C 1107, 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 EARTHWORK

A. Comply with requirements in Division 2 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

A. Drawing shall show 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 type K copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install underground type K copper tube in PE encasement according to ASTM A 674 or AWWA C105.

D. Install shutoff valve, hose-end drain valve, strainer, water pressure reducing valve, pressure gages, and test tee with valve, inside the building at each domestic water service entrance. Comply with requirements in Division 15 Section "Meters and Gages for Plumbing Piping" for pressure gages and Division 15 Section "Domestic Water Piping Specialties" for drain valves and strainers.

E. Install shutoff valve immediately upstream of each dielectric fitting.

F. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements in Division 15 Section "Domestic Water Piping Specialties" for pressure-reducing valves.

G. Install domestic water piping level without pitch and plumb.

H. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

I. Install seismic restraints on piping. Comply with requirements in Division 15 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.

J. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

K. Install piping at right angles and parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

L. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

M. Install piping adjacent to equipment and specialties to allow service and maintenance.

N. Install piping to permit valve servicing.

O. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.

P. Install piping free of sags and bends.

Q. Install fittings for changes in direction and branch connections.

R. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

S. Install pressure gages on suction and discharge piping from each plumbing pump. Comply with requirements in Division 15 Section "Meters and Gages for Plumbing Piping" for pressure gages.

T. Install thermostats in hot-water circulation piping. Comply with requirements in Division 15 Section "Domestic Water Pumps" for thermostats.

U. Install thermometers on outlet piping from each water heater. Comply with requirements in Division 15 Section "Meters and Gages for Plumbing Piping" for thermometers.

3.3 JOINT CONSTRUCTION

A. Ream ends of copper tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of tubes and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.

E. Soldered Joints: 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."

F. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.4 VALVE INSTALLATION

A. General-Duty Valves: Comply with requirements in Division 15 Section "General-Duty Valves for Plumbing Piping" for valve installations.

B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball valves for piping NPS 2 and smaller. Use butterfly valves for piping NPS 2-1/2 and larger.

C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 15 Section "Domestic Water Piping Specialties."

1. Hose-End Drain Valves: At low points in water mains, risers, and branches.

D. Install balancing valve in each hot-water circulation return branch and discharge side of each pump and circulator. Set balancing valves partly open to restrict but not stop flow. Use ball valves for piping NPS 2 and smaller and butterfly valves for piping NPS 2-1/2 and larger. Comply with requirements in Division 15 Section "Domestic Water Piping Specialties" for balancing valves.

3.5 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:

1. NPS 1-1/2 and Smaller: Fitting-type coupling.
2. NPS 2 and Larger: Sleeve-type coupling.

3.6 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flange kits.

D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.7 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Division 15 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.

B. Comply with requirements in Division 15 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.

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.

3. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

E. 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.
6. NPS 6: 10 feet with 5/8-inch rod.

F. Install supports for vertical copper tubing every 10 feet.

G. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.8 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment and machines to allow 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 required by plumbing code. Comply with requirements in Division 15 plumbing fixture Sections for connection sizes.
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.

3.9 SLEEVE INSTALLATION

A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.

B. Sleeves are not required for core-drilled holes.

C. Permanent sleeves are not required for holes formed by removable PE sleeves.

D. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.

E. Install sleeves in new partitions, slabs, and walls as they are built.

F. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint.

G. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint.

H. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals specified in this Section.

I. Seal space outside of sleeves in concrete slabs and walls with grout.

J. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated.

K. Install sleeve materials according to the following applications:

1. Sleeves for Piping Passing through Concrete Floor Slabs: Steel pipe.
2. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Steel pipe.

    a. Extend sleeves 2 inches above finished floor level.
    b. For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Comply with requirements in Division 7 Section "Sheet Metal Flashing and Trim" for flashing.

3. Sleeves for Piping Passing through Gypsum-Board Partitions:

    a. PVC pipe sleeves for pipes smaller than NPS 6.
    b. Exception: Sleeves are not required for water supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.

4. Sleeves for Piping Passing through Concrete Roof Slabs: Steel pipe Insert type.
5. Sleeves for Piping Passing through Exterior Concrete Walls:

    a. Steel pipe sleeves for pipes smaller than NPS 6.
    b. Install sleeves that are large enough to provide 1-inch annular clear space between sleeve and pipe or pipe insulation when sleeve seals are used.
    c. Do not use sleeves when wall penetration systems are used.

6. Sleeves for Piping Passing through Interior Concrete Walls:

    a. Steel pipe sleeves for pipes smaller than NPS 6.

L. 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 in Division 7 Section "Through-Penetration Firestop Systems" for firestop materials and installations.

3.10 SLEEVE SEAL INSTALLATION

A. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.

B. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.11 IDENTIFICATION

A. Identify system components. Comply with requirements in Division 15 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.

3.12 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Piping Inspections:

1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
2. During installation, notify authorities having jurisdiction at least 72 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

   a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
   b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

C. Piping Tests:

1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
2. Test for leaks and defects in piping. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.

3. Leave domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
4. Cap and subject piping to static water pressure of 100 psig, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
6. Prepare reports for tests and for corrective action required.

D. Domestic water piping will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.13 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 flow of hot water 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.

3.14 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping before using.
2. Use purging and disinfecting 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. Submit water samples in sterile bottles to testing lab. Repeat procedures if biological examination shows contamination.

B. Prepare and submit reports of purging and disinfecting activities.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.15 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, domestic water, building service piping, NPS 3 and smaller, shall be the following:

1. Hard copper tube, ASTM B 88, Type K; wrought-copper solder-joint fittings; and brazed joints.

D. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 and larger, shall be one of the following:

1. Hard copper tube, ASTM B 88, Type K; wrought-copper solder-joint fittings; and brazed joints.
2. Mechanical-joint, ductile-iron pipe; standard- pattern mechanical-joint fittings; and mechanical joints.

E. Aboveground domestic water piping, NPS 2 and smaller, shall be the following:

1. Hard copper tube, ASTM B 88, Type L; cast- or wrought- copper solder-joint fittings; and soldered joints.

F. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L; wrought- copper solder-joint fittings; and soldered joints.

G. Aboveground domestic water piping, NPS 5 to NPS 8, shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L; wrought- copper solder-joint fittings; and soldered joints.

3.16 VALVE SCHEDULE

A. Drawings shall indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use ball valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
2. Throttling Duty: Use ball valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
3. Hot-Water Circulation Piping, Balancing Duty: Memory-stop balancing or ball valves.
4. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION 15140

SECTION 15145 - 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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following domestic water piping specialties:

1. Vacuum breakers.
2. Backflow preventers.
3. Water pressure-reducing valves.
4. Temperature-actuated water mixing valves.
5. Strainers.
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.

1.3 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.4 SUBMITTALS

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

B. Field quality-control test reports.

C. Operation and Maintenance Data: For domestic water piping specialties 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, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. NSF Compliance:

1. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

PART 2 - PRODUCTS

2.1 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

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

   a. Ames Co.
   b. Cash Acme.
   c. Conbraco Industries, Inc.
   d. FEBCO; SPX Valves & Controls.
   e. Rain Bird Corporation.
   f. Toro Company (The); Irrigation Div.
   g. Watts Industries, Inc.; Water Products Div.
   h. Zurn Plumbing Products Group; Wilkins Div.
   i. Prior approved equal.

2. Standard: ASSE 1001.
3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
4. Body: Bronze.
5. Inlet and Outlet Connections: Threaded.
6. Finish: Rough bronze.

B. Hose-Connection Vacuum Breakers:

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

   a. Arrowhead Brass Products, Inc.
   b. Cash Acme.
   c. Conbraco Industries, Inc.
   d. Legend Valve.
   e. MIFAB, Inc.
   f. Prier Products, Inc.
   g. Watts Industries, Inc.; Water Products Div.
   h. Woodford Manufacturing Company.
   i. Zurn Plumbing Products Group; Light Commercial Operation.
   j. Zurn Plumbing Products Group; Wilkins Div.
   k. Prior approved equal.

2. Standard: ASSE 1011.
3. Body: Bronze, nonremovable, with manual drain.

4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
5. Finish: Chrome or nickel plated.

2.2 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:

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

   a. Ames Co.
   b. Conbraco Industries, Inc.
   c. FEBCO; SPX Valves & Controls.
   d. Flomatic Corporation.
   e. Watts Industries, Inc.; Water Products Div.
   f. Zurn Plumbing Products Group; Wilkins Div.
   g. Prior approved equal.

2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
5. Body: Bronze for NPS 2 and smaller; steel with interior lining complying 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. Accessories:

   a. Valves: Ball type with threaded ends on inlet and outlet ofNPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
   b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

B. Hose-Connection Backflow Preventers:

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

   a. Conbraco Industries, Inc.
   b. Watts Industries, Inc.; Water Products Div.
   c. Woodford Manufacturing Company.
   d. Prior approved equal.

3. Standard: ASSE 1052.
4. Operation: Up to 10-foot head of water back pressure.
5. Inlet Size: NPS 1/2 or NPS 3/4.
6. Outlet Size: Garden-hose thread complying with ASME B1.20.7.
7. Capacity: At least 3-gpm flow.

2.3 WATER PRESSURE-REDUCING VALVES

A. Water Regulators:

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

   a. Watts Industries, Inc.; Water Products Div.
   b. Cash Acme.
   c. Conbraco Industries, Inc.
   d. Zurn Plumbing Products Group; Wilkins Div.
   e. Prior approved equal.

2. Standard: ASSE 1003.
3. Pressure Rating: Initial working pressure of 150 psig.
4. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3.
5. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.
6. Provide with or without integral strainer.

2.4 TEMPERATURE-ACTUATED WATER MIXING VALVES

A. Water-Temperature Limiting Devices:

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

   a. Powers; a Watts Industries Co.
   b. Armstrong International, Inc.
   c. Symmons Industries, Inc.
   d. Watts Industries, Inc.; Water Products Div.
   e. Zurn Plumbing Products Group; Wilkins Div.
   f. Prior approved equal.

2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig.
4. Type: Thermostatically controlled water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded inlets and outlet.
7. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Valve Finish: Chrome plated.

B. Primary, Thermostatic, Water Mixing Valves:

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

   a. Powers; a Watts Industries Co.

b. Armstrong International, Inc.
c. Lawler Manufacturing Company, Inc.
d. Leonard Valve Company.
e. Symmons Industries, Inc.
f. Prior approved equal.

2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig.
4. Type: Cabinet-type, thermostatically controlled water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded inlets and outlet.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Valve Pressure Rating: 125 psig minimum, unless otherwise indicated.
9. Valve Finish: Chrome plated.
10. Piping Finish: Chrome plated.

C. Individual-Fixture, Water Tempering Valves:

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

a. Sloan.
b. Watts.
c. Prior approved equal.

2. Standard: ASSE 1016, thermostatically controlled water tempering valve.
3. Pressure Rating: 125 psig minimum, unless otherwise indicated.
4. Body: Bronze body with corrosion-resistant interior components.
5. Temperature Control: Adjustable.
6. Inlets and Outlet: Threaded.
7. Finish: Rough or chrome-plated bronze.
8. Tempered-Water Setting: 110° F.
9. Tempered-Water Design Flow Rate: Coordinate with 15410.

2.5 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 complying with AWWA C550 or FDA-approved, epoxy coating and 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. Drain: Factory-installed, hose-end drain valve.

2.6 HOSE BIBBS

A. Hose Bibbs:

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 3/4 threaded or 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: Chrome.
9. Finish for Service Areas: Chrome or nickel plated.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle.
12. Operation for Service Areas: Wheel handle.
13. Operation for Finished Rooms: Operating key.
14. Include operating key with each operating-key hose bibb.
15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.7 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:

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

   a. Josam Company.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Woodford Manufacturing Company.
   g. Zurn.
   h. Prior approved equal.

2. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig.
4. Operation: Loose key.
5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
6. Inlet: NPS 3/4.
7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
8. Box: Deep, flush mounting with cover.
9. Box and Cover Finish: Polished nickel bronze.
10. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
11. Nozzle and Wall-Plate Finish: Rough bronze.

12. Operating Keys(s): One with each wall hydrant.

B. Vacuum Breaker Wall Hydrants:

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

   a. Smith, Jay. R. Mfg. Co.; Division of Smith Industries, Inc.
   b. Arrowhead Brass Products, Inc.
   c. Watts Industries, Inc.; Water Products Div.
   d. Woodford Manufacturing Company.
   e. Zurn Plumbing Products Group; Light Commercial Operation.
   f. Prior approved equal.

2. Standard: ASSE 1019, Type A or Type B.
3. Type: Freeze-resistant, automatic draining with integral air-inlet valve.
4. Classification: Type B, for automatic draining with hose removed or with hose attached and nozzle closed.
5. Pressure Rating: 125 psig.
6. Operation: Loose key.
7. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
8. Inlet: NPS 3/4.
9. Outlet: Exposed with garden-hose thread complying with ASME B1.20.7.

2.8 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.

2.9 WATER HAMMER ARRESTERS

A. Water Hammer Arresters:

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

   a. AMTROL, Inc.
   b. Josam Company.

c. MIFAB, Inc.
d. Sioux Chief Manufacturing Company, Inc.
e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
f. Tyler Pipe; Wade Div.
g. Watts Drainage Products Inc.
h. Zurn.
i. Prior approved equal.

2. Standard: ASSE 1010 or PDI-WH 201.
3. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.10 AIR VENTS

A. Bolted-Construction Automatic Air Vents:

1. Body: Bronze.
2. Pressure Rating: 125-psig minimum pressure rating at 140 deg F.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 1/2 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

2.11 TRAP-SEAL PRIMER VALVES

A. Supply-Type, Trap-Seal Primer Valves:

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

a. MIFAB, Inc.
b. PPP Inc.
c. Sioux Chief Manufacturing Company, Inc.
d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
e. Watts Industries, Inc.; Water Products Div.
f. Prior approved equal.

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. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

2.12 TRAP-SEAL PRIMER SYSTEMS

A. Trap-Seal Primer Systems:

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

   a. PPP Inc.
   b. Prior approved equal.

2. Standard: ASSE 1044,
3. Piping: NPS 3/4, ASTM B 88, Type L; copper, water tubing.
4. Cabinet: Recessed-mounting steel box with stainless-steel cover.
5. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120-V ac power.
6. Vacuum Breaker: ASSE 1001.
7. Size Outlets: NPS 1/2.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for piping joining materials, joint construction, and basic installation requirements.

B. 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 not acceptable for this application.
   3. Do not install bypass piping around backflow preventers.

C. Install water regulators with inlet and outlet shutoff valves and bypass with memory-stop balancing valve. Install pressure gages on inlet and outlet.

D. Install balancing valves in locations where they can easily be adjusted. Install on hot water recirculating lines where they connect to hot water lines.

E. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.

   1. Install thermometers.
   2. Install cabinet-type units recessed in or surface mounted on wall as specified.

F. Install Y-pattern strainers for water on supply side of each water pressure-reducing valve.

G. Install water hammer arresters in water piping according to PDI-WH 201.

H. Install air vents at high points of water piping. Install drain piping and discharge onto floor drain.

I. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

J. 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.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings shall indicate general arrangement of piping and specialties.

B. Ground equipment according to Division 16 Section "Grounding and Bonding."

C. Connect wiring according to Division 16 Section "Conductors and Cables."

3.3 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Pressure vacuum breakers.
2. Reduced-pressure-principle backflow preventers.
3. Water pressure-reducing valves.
4. Calibrated balancing valves.
5. Primary, thermostatic, water mixing valves.
6. Supply-type, trap-seal primer valves.
7. Trap-seal primer systems.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and prepare test reports:

1. Test each reduced-pressure-principle backflow preventer according to authorities having jurisdiction and the device's reference standard.

B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.5 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves.

C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION 15145

SECTION 15150 - 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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following for soil, waste, and vent piping inside the building:

1. Pipe, tube, and fittings.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

C. LLDPE: Linear, low-density polyethylene plastic.

D. NBR: Acrylonitrile-butadiene rubber.

E. PE: Polyethylene plastic.

F. PVC: Polyvinyl chloride plastic.

G. TPE: Thermoplastic elastomer.

1.4 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 Insert pressure.

1.5 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

B. Field quality-control inspection and test reports.

1.6 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. 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; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS - UNDER FLOOR.

A. Pipe and Fittings: ASTM A 74, Service and Extra-Heavy class(es).

B. Gaskets: ASTM C 564, rubber.

C. Calking Materials: ASTM B 29.

2.4 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Sovent Stack Fittings: ASME B16.45 or ASSE 1043, hubless, cast-iron aerator and deaerator drainage fittings.

C. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.

1. Standard, Shielded, Stainless-Steel Couplings: CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve.

a. Manufacturers:

1) ANACO.
2) Fernco, Inc.
3) Ideal Div.; Stant Corp.
4) Mission Rubber Co.
5) Tyler Pipe; Soil Pipe Div.
6) Prior approved equal.

2. Heavy-Duty, Shielded, Stainless-Steel Couplings: With stainless-steel shield, stainless-steel bands and tightening devices, and ASTM C 564, rubber sleeve.

a. Manufacturers:

1) ANACO.
2) Clamp-All Corp.
3) Ideal Div.; Stant Corp.
4) Mission Rubber Co.
5) Tyler Pipe; Soil Pipe Div.
6) Prior approved equal.

3. Heavy-Duty, Shielded, Cast-Iron Couplings: ASTM A 48/A 48M, two-piece, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve.

a. Manufacturers:

1) MG Piping Products Co.
2) Prior approved equal.

2.5 PVC PIPE AND FITTINGS BELOW GRADE ONLY.

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

1. PVC Socket Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns.

B. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.

1. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

C. Cellular-Core, Sewer and Drain Series, PVC Pipe: ASTM F 891, Series PS 100.

1. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Series PS 100 sewer and drain pipe.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Refer to Division 2 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

A. Aboveground, soil and waste piping NPS 4 and smaller shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless cast-iron soil pipe and fittings standard, shielded, stainless-steel couplings; and hubless-coupling joints.

B. Aboveground, soil and waste piping NPS 5 and larger shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless cast-iron soil pipe and fittings; standard, and heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.

C. Aboveground, vent piping shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel couplings; and hubless-coupling joints.

D. Underground, soil, waste, and vent piping shall be any of the following:

1. Extra-Heavy class, cast-iron soil piping; gaskets; and gasketed calking materials; joints.
2. Cellular-core PVC pipe, PVC socket fittings, and solvent-cemented joints.
3. Cellular-core, Sewer and Drain Series, PVC pipe; PVC socket fittings; and solvent-cemented joints.

3.3 PIPING INSTALLATION

A. Sanitary sewer piping outside the building is specified in Division 2 Section "Sanitary Sewerage."

B. Basic piping installation requirements are specified in Division 15 Section "Basic Mechanical Materials and Methods."

C. Install seismic restraints on piping. Seismic-restraint devices are specified in Division 15 Section "Mechanical Vibration and Seismic Controls."

D. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers. Provide concrete around manhole.

E. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 15 Section "Basic Mechanical Materials and Methods."

F. Install wall-penetration fitting at each service pipe penetration through foundation wall. Make installation watertight.

G. 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.

H. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. 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. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. 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.

I. Lay buried building 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.

J. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:

1. Building Sanitary 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 Sanitary Drainage Piping: 2 percent downward in direction of flow.
3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

K. Install engineered soil and waste drainage and vent piping systems as follows:

1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.

L. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

M. Install underground PVC soil and waste drainage piping according to ASTM D 2321.

N. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.4 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 15 Section "Basic Mechanical Materials and Methods."

B. 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.

C. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook".

D. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

3.5 HANGER AND SUPPORT INSTALLATION

A. Seismic-restraint devices are specified in Division 15 Section "Mechanical Vibration Controls and Seismic Restraints."

B. Pipe hangers and supports are specified in Division 15 Section "Hangers and Supports." Install the following:

1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Install individual, straight, horizontal piping runs according to the following:

   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.

3. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Install supports according to Division 15 Section "Hangers and Supports."

D. Support vertical piping and tubing at base and at each floor.

E. Rod diameter may be reduced 1 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: 60 inches with 3/4-inch rod.
5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.

G. Install supports for vertical cast-iron soil piping every 15 feet.

H. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

A. Drawings shall 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 drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage 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 drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.

3.7 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 drainage 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 piping. 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, drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. 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. 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.

Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.

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.

3.8 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.

END OF SECTION 15150

SECTION 15155 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following sanitary drainage piping specialties:

1. Cleanouts.
2. Floor drains.
3. Floor sinks.
4. Roof flashing assemblies.
5. Through-penetration firestop assemblies.
6. Miscellaneous sanitary drainage piping specialties.
7. Flashing materials.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. FRP: Fiberglass-reinforced plastic.

C. HDPE: High-density polyethylene plastic.

D. PE: Polyethylene plastic.

E. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include manufacturer, rated capacities, operating characteristics, and accessories for the following:

1. Cleanouts.
2. Floor drains.

1.5 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.6 COORDINATION

A. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 CLEANOUTS

A. Exposed Metal Cleanouts:

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

   a. Josam Company; Josam Div.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation.
   g. Prior approved equal.

2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
3. Size: Same as connected drainage piping
4. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch or Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head, cast-iron plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Locate in accessible locations.

B. Metal Floor Cleanouts:

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

   a. Josam Company; Josam Div.
   b. MIFAB.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Light Commercial Operation.

g. Zurn Plumbing Products Group; Specification Drainage Operation.
h. Prior approved equal.

2. Standard: ASME A112.36.2M for threaded, adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Threaded, adjustable housing.
5. Body or Ferrule: Cast iron.
6. Clamping Device: Required.
7. Outlet Connection: Threaded.
8. Closure: Cast-iron plug.
9. Adjustable Housing Material: Cast iron with threads.
10. Frame and Cover Material and Finish: Nickel-bronze or copper alloy.
11. Frame and Cover Shape: Round.
12. Top Loading Classification: Medium Duty.
13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
14. Standard: ASME A112.3.1.
15. Size: Same as connected branch.
16. Housing: Stainless steel.
17. Closure: Stainless steel with seal.
18. Riser: Stainless-steel drainage pipe fitting to cleanout.

C. Cast-Iron Wall Cleanouts:

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

a. Josam Company; Josam Div.
b. MIFAB, Inc.
c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
d. Tyler Pipe; Wade Div.
e. Watts Drainage Products Inc.
f. Zurn Plumbing Products Group; Specification Drainage Operation.
g. Prior approved equal.

2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hub-and-spigot, cast-iron soil pipe T-branch or Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head, cast-iron plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, stainless-steel wall-installation frame and cover.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains:

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

a. Zurn.
b. Josam Company; Josam Div.
c. MIFAB, Inc.
d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
e. Tyler Pipe; Wade Div.
f. Watts Drainage Products Inc.
g. Prior approved equal.

2. Standard: ASME A112.6.3.
3. Pattern: Floor drain.
4. Body Material: Gray iron.
5. Clamping Device: Required.
6. Outlet: Bottom.
7. Top or Strainer Material: Stainless steel.
8. Top Shape: Round.
9. Top Loading Classification: Medium Duty.
10. Inlet Fitting: Gray iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
11. Trap Pattern: Deep-seal P-trap.
12. Trap Features: Trap-seal primer valve drain connection.

2.3 FLOOR SINK

A. 12x12x6 with square top, medium receptor cast iron body with flanged receptor, acid resistant coated interior, and acid resistant coated half grate. Aluminum sediment bucket and 3 inch caulked regular outlet connection and deep seal P-Traps.

B. Approved Manufacturers:

1. American Standard 7764
2. Kohler 6454
3. Smith 3411
4. Wade W9100
5. Zurn 1900
6. Prior approved equal.

2.4 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:

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

a. Acorn Engineering Company; Elmdor/Stoneman Div.
b. Thaler Metal Industries Ltd.
c. Prior approved equal.

B. Description: Manufactured assembly made of copper flashing collar and skirt extending at least 8 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.

1. Open-Top Vent Cap: Without cap.
2. Low-Silhouette Vent Cap: With vandal-proof vent cap.
3. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.5 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:

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

   a. ProSet Systems Inc.
   b. Prior approved equal.

2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
3. Size: Same as connected soil, waste, or vent stack.
4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
5. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
6. Special Coating: Corrosion resistant on interior of fittings.

2.6 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. Vent Caps:

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

2.7 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:

1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.
3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.

B. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:

1. General Applications: 12 oz./sq. ft. thickness.
2. Vent Pipe Flashing: 8 oz./sq. ft. thickness.

C. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.

D. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

E. Fasteners: Metal compatible with material and substrate being fastened.

F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

G. Solder: ASTM B 32, lead-free alloy.

H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 15 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

B. 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.

C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

E. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance.
2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. 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.

3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

F. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

G. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

H. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations.

I. Install deep-seal traps on all floor drains.

J. 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.

K. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

L. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

M. Install vent caps on each vent pipe passing through roof.

N. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. 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. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

1. Copper Sheets: Solder joints of copper sheets.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 7 Section "Sheet Metal Flashing and Trim."

F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Leak Test: After installation, charge system 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.

3.5 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 15155

SECTION 15170 - EXTERIOR DIRECT BURIED PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes piping for steam distribution systems outside the building. Piping includes pipes, fittings, valves, insulation, and specialties for the following:

1. Direct-bury, bare piping with field-installation, loose-fill insulation.
2. Direct-bury, conduit piping system.
3. Tie into existing campus high pressure steam and condensate piping.

B. Related Sections include the following:

1 Division 3 Section "Cast-in-Place Concrete" for lightweight concrete aggregate used in conduit systems for pipe supports.
2 Division 15 Section "Steam and Condensate Piping" for steam and condensate piping systems inside the building.
3 Division 15 Section “Hydronic Piping’ for chilled water piping systems inside the building.

1.3 DEFINITIONS

A. The following are industry abbreviations for plastic piping materials:

1 PTFE: Polytetrafluoroethylene plastic.
2 RTRP: Fiberglass, reinforced-thermosetting-resin pipe.

B. Thermal Conductivity and Apparent Thermal Conductivity (k-Value): As defined in ASTM C 168. In this Section, these values are the result of the formula Btu x in./h x sq. ft. x deg F or W/m x K at the temperature differences specified. Values are expressed as Btu or W.

1. Example: Apparent Thermal Conductivity (k-Value): 0.26 or 0.037.

1.4 SUBMITTALS

A. Product Data: Include carrier piping, insulation type and k-value, casing, and major components for each conduit piping system.

B. Product Data: Include carrier piping, insulation type and k-value, jacket, end seals, and major components for each cased piping system.

C. Product Data: For loose-fill pipe insulation.

D. Product Data: For steam traps and air vents.

E. Shop Drawings: Detail fabrication of anchors, alignment guides, supports, and expansion loops, for loose-fill insulation system.

F. Installer Certificates: Welders' certificates for welding processes and operators.

G. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

H. Warranties: Special warranties specified in this Section.

1.5 DESIGN

A. Manufacturer shall provide complete design of the piping system to allow for thermal movement of the pipe, within allowable stresses. System design shall be in strict accordance with ANSI B31.1. Design/build contractor shall provide details for both the direct buried loose-fill insulation and the steam conduit system.

1.6 COORDINATION

A. Coordinate pipe-fitting pressure classes with products specified in related Sections to allow matching of flange boltholes.

1.7 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Special Warranty: Submit a written warranty, executed by Contractor, to repair dry, testable, conduit systems and replace components damaged by failure.

1. Warranty Period: Manufacturer's standard, but not less than five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PIPES AND TUBES

A. General: Applications of the following pipe and tube materials are indicated in schedules at the end of Part 3.

B. Steel Pipe, 2-Inch NPS and Smaller: ASTM A 53; Type S, seamless; Grade A; Schedule 40; and plain ends, unless otherwise indicated.

C. Steel Pipe, 2-1/2-to 10-Inch NPS: ASTM A 53; Type E, electric-resistance welded; Grade B; Schedule 40; and plain ends, unless otherwise indicated.

D. Steel Pipe Nipples, 10-Inch NPS and Smaller: ASTM A 733, Schedule 40, seamless, carbon-steel pipe complying with ASTM A 53.

2.2 PIPE AND TUBE FITTINGS

A. General: Applications of the following pipe and tube fitting materials are indicated in schedules at the end of Part 3.

B. Malleable-Iron Unions: ASME B16.39 malleable-iron, Class 150, hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends, with threads according to ASME B1.20.1.

C. Malleable-Iron, Threaded Fittings: ASME B16.3, Class 150, with threads according to ASME B1.20.1. Furnish Class 300 if required to match piping.

D. Cast-Iron, Threaded Fittings: ASME B16.4, Class 125, standard pattern, with threads according to ASME B1.20.1. Furnish Class 250 if required to match piping.

E. Cast-Iron, Threaded Flanges: ASME B16.1, Class 125, raised ground face, boltholes spot faced. Furnish Class 250 if required to match system, operating pressure, or companion flanges.

F. Steel Flanges and Flanged Fittings: ASME B16.5, steel; including bolts, nuts, and gaskets, butt-welded end connection, and raised face. Furnish with dimensions to match companion flanges.

G. Steel Welding Fittings: ASTM A 234/A 234M, seamless or welded.

2.3 PIPING: (UNDERGROUND PRE-INSULATED SYSTEM) CHILLED WATER ONLY:

A. The underground exterior chilled water piping, shall be installed in an insulated underground piping system to enclose and provide mechanical and waterproofing protection for free unrestricted movement of piping specified. The system supplier shall have at least five years experience fabricating systems on this kind. All components of this system shall be made in the USA and shall be so stamped or labeled.

1. General

    a. All underground lines as indicated on contract drawings provided by design/build contractor shall be the drainable and dryable type.
    b. All straight sections, fittings, anchors and other accessories shall be factory prefabricated to job dimensions and designed to minimize the number of field welds.
    c. Each system layout shall be computer analyzed by the piping system manufacturer to determine stresses on the carrier pipe and anticipated thermal movement of the service pipe.
    d. The system design shall be in strict conformance with ANSI B31.1, latest edition. Factory trained field technical assistance shall be provided for the critical periods of installation, i.e., unloading, field joint instruction and testing.

2. Service Pipe

    a. Internal piping shall be standard weight Schedule 40 carbon steel.
    b. All joints shall be butt-welded for sizes 2-1/2 inches and greater, and socket welded for 2 inches and below.
    c. Where possible, provide straight sections in 40 foot random lengths with 6 inches of piping exposed at each end for field joint fabrication.

3. Sub-Assemblies

    a. End seals, gland seals, and anchors shall be designed and factory prefabricated to prevent the ingress of moisture into the system.
    b. All sub-assemblies shall be designed to allow for complete draining and drying of the conduit system.

4. Insulation

    a. Service pipe insulation shall be polyurethane, k=0.14, 2.0-3.opcf.
    b. The insulation shall have passed the most recent boiling test and other requirements specified in the Federal Agency Guidelines Specifications.
    c. The insulation shall be applied to a thickness of 2 inches.
    d. Include mastic moisture barrier end seals.

5 Outer Jacket:

6. Pipe Supports

a. All pipes within the outer casing shall be supported at not more than 10 foot intervals. These supports shall be designed to allow for continuous airflow and drainage of the conduit in place. The straight supports shall be designed to occupy not more than 10% of the annular air space.

b. Supports shall be of the type where insulation thermally isolates the carrier pipe from the outer conduit. Supports which directly contact both the carrier pipe and the outer casing shall not be allowed. The surface of the insulation shall be protected at the support by a sleeve not less than 12 inches long, fitted with traverse and where required, rotational arresters.

B. Approved Manufacturers -

1. Thermacor or equal by
2. Perma Pipe
3. Ricwill
4. Prior approved equal.

2.4 LOOSE-FILL INSULATION - STEAM AND CONDENSATE PIPING

A. Granular, Loose-Fill Insulation: Inorganic, nontoxic, nonflammable, sodium-potassium aluminum silicate with calcium-carbonate filler. Include chemical treatment that renders insulation hydrophobic.

1. Thermal Conductivity (k-Value): 0.60 at 175 deg F and 0.65 at 300 deg F.

a. Dry Density: 40 to 42 lb/cu. ft.
b. Strength: 12,000 lb/sq. ft.

B. Powder, Loose-Fill Insulation: Inert, nontoxic, nonflammable, calcium-carbonate particles. Include chemical treatment that renders insulation hydrophobic.

1 Thermal Conductivity (k-Value): ASTM C 177, 0.58 at 100 deg F and 0.68 at 300 deg F.
2 Dry Density: Approximately 60 lb/cu. ft.
3 Strength: 12,000 lb/sq. ft.

C. Manufacturers

1. Gilsulate
2. Dry-therm
3. Prior approved equal

2.5 JOINING MATERIALS

A. General: Applications of the following piping joining materials are indicated in schedules at the end of Part 3.

B. Refer to Division 2 Section "Utility Materials" for commonly used joining materials.

C. Gasket Materials: ASME B16.21, nonmetallic, asbestos free, and suitable for system liquid design temperatures and pressures.

D. Welding Materials: Comply with the ASME Boiler and Pressure Vessel Code: Section II, Part C, for materials appropriate for pipe being welded.

E. Transition Couplings: Coupling or other manufactured fitting same size as, with pressure rating at least equal to, and with ends compatible with piping to be joined.

2.6 VALVES

A. Cast-Iron Gate Valves: MSS SP-70; Class 125; ASTM A 126 cast-iron body and bonnet, solid cast-iron wedge, brass-alloy stem, outside screw and yoke, PTFE-impregnated packing with two-piece packing gland assembly, flanged-end connections; with cast-iron handwheel.

B. Ball Valves: MSS SP-110; 600-psig cold working-pressure rating; ASTM B 584 bronze body and bonnet, two-piece construction, chrome-plated brass ball, conventional port, blowout-proof, bronze or brass stem; PTFE seats and seals; threaded-end connections; stem extension; and vinyl-covered steel lever handle.

2.7 STEAM TRAPS

A. Float-and-Thermostatic Steam Traps: ASTM A 278, Class No. 30 cast-iron body and bolted cap; renewable, stainless-steel float mechanism, with renewable, hardened stainless-steel head and seat; balanced-pressure thermostatic air vent made of stainless-steel or Monel bellows with stainless-steel head and seat.

1. Material Option: ASTM A 126, cast-iron body.

B. Inverted-Bucket Steam Traps: ASTM A 278, Class No. 30 (ASTM A 278M, Class No. 150) cast-iron body and cap, pressure rated for 250 psig; stainless-steel head and seat; stainless-steel valve retainer, lever, guide-pin assembly, brass or stainless-steel bucket.

2.8 AIR VENTS

A. Bellows, Air Vents: Cast-iron, brass, or stainless-steel body, pressure rated for 250 psig. Include balanced-pressure, stainless-steel or Monel, thermostatic bellows; stainless-steel heads and seats; and threaded-vent

and -end connections.

2.9 STRAINERS

A. Y-Pattern Strainers: 250-psig minimum steam working pressure; body of cast iron complying with ASTM A 278, Class No. 30 (ASTM A 278M, Class No. 150). Include manufacturer's recommended stainless-steel mesh screen for 2-inch NPS and smaller, and manufacturer's recommended perforations for 2-1/2-inch NPS and larger; tapped blow-off plug; and threaded-or flanged-end connections.

1. Material Option: ASTM A 126, cast-iron body.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Below Grade

1. Before connecting into the existing high pressure steam system, Contractor shall have approval from the Physical Plant Department.

3.2 TRENCHING, LOOSE-FILL INSULATION, AND BACKFILLING

A. Refer to Division 2 Section "Earthwork" for excavating, trenching, and backfilling for underground piping.

B. Install loose-fill insulation and accessories according to manufacturer's written instructions.

3.3 INSTALLATION OF CONDUIT PIPING

A. The installing contractor shall handle the system in accordance with the directions furnished by the manufacturer and as approved by the Engineer.

B. The casing shall be air tested at 15 psig and the service piping shall be hydrostatically hammer tested to 150 psig or 1 1/2 times the operating pressure, or as specified in the contract documents. The test pressure shall be held for not less than one hour.

C. The contractor shall holiday test the entire conduit system at 5,000 volts. All holidays shall be repaired and tested.

D. Backfill

1. A 4 inch layer of sand or fine gravel shall be placed and

tamped in the trench to provide a uniform bedding for the conduit.

2. The entire trench shall be evenly backfilled with a similar material as the bedding in 6 inch compacted layers to a minimum height of 6 inches above the top of the insulated piping system. The remaining trench shall be evenly and continuously backfilled in uniform layers with suitable excavated soil.

3.4 JOINT CONSTRUCTION

A. Refer to Division 2 Section "Utility Materials" for basic piping joint construction. Where specific joint construction is not indicated, follow piping manufacturer's written instructions.

3.5 PIPING INSTALLATION

A. General Locations and Arrangements: Drawings indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and other design considerations. Install piping as indicated, unless deviations to layout are approved on Coordination Drawings.

B. Install steam supply piping at uniform grade of 0.2 percent downward in direction of flow.

C. Install condensate return piping at uniform grade of 0.4 percent downward in direction of flow.

D. Install components with pressure rating equal to or greater than system operating pressure.

E. Install piping free of sags and bends.

F. Install fittings for changes in direction and branch connections.

G. Install branch connections to steam supply mains using 45-degree fittings in main with takeoff out top of main. Use of 90-degree tee fittings is permissible if 45-degree fittings are not practical. If length of branch takeoff is less than 10 feet (3 m), pitch branch piping down toward main at 0.4 percent.

H. Install drains where shown and at low points consisting of tee fitting, 3/4-inch NPS (DN20) ball valve, and short 3/4-inch NPS (DN20) threaded nipple and cap.

I. Make reductions in pipe sizes using eccentric reducer fitting installed with level side down.

J. Install couplings according to manufacturer's written instructions.

K. Refer to Division 15 Section "Basic Mechanical Materials and Methods"

for sleeves and mechanical sleeve seals through exterior building walls.

L. Piping Connections: Unless otherwise indicated, make piping connections as specified below:

1 Install unions in piping 2-inch NPS (DN50) and smaller adjacent to each valve and at final connection to each piece of equipment with 2-inch NPS (DN50) or smaller threaded pipe connection.
2 Install flanges in piping 2-1/2-inch NPS (DN65) and larger adjacent to flanged valves and at final connection to each piece of equipment with flanged pipe connection.

M. Install pipe alignment guides on piping that adjoins pipe expansion joints. Secure aboveground pipe alignment guides to piping supports. Anchor underground piping with concrete thrust blocks.

N. Install pipe anchors to prevent stresses from exceeding those permitted by ASME B31.1 and ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

1 Fabricate and install anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.1, ASME B31.9, and AWS D1.1.
2 Where pipe expansion joints are indicated, install pipe anchors and alignment guides according to expansion joint manufacturer's written instructions to control movement.

O. Install drip legs at low points of piping and natural drainage points such as ends of mains, bottoms of risers, and upstream of pressure regulators, control valves, isolation valves, pipe bends, and expansion joints.

1 Install drip legs on straight piping with no natural drainage points, at intervals not exceeding 200 feet (60 m) if pipe is pitched down in direction of steam flow, and at maximum of 150 feet (45 m) if pipe is pitched up in direction of steam flow.
2 Size drip legs full size of pipe at vertical risers and extend beyond rise. Size drip legs at other locations same as main. Include 18-inch- (450-mm-) long drip leg for steam mains 6-inch NPS (DN150) and smaller. Include drip legs two pipe sizes smaller than, but not less than, 4-inch NPS (DN100) in steam mains 6-inch NPS (DN150) and larger.
3 Equip drip legs, dirt pockets, and strainer blowdowns with gate valves to allow removal of dirt and scale.
4 Install steam traps close to drip legs.

P. Valve Applications: Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Install valves at each branch connection to supply mains, at

supply connection to each piece of equipment, and elsewhere as indicated.

a. Shutoff Duty, 2-Inch NPS (DN50) and Smaller: Bronze-body gate valves.
b. Shutoff Duty, 2-1/2-Inch NPS (DN65) and Larger: Cast-iron-body gate valves.

Q. Steam Trap Applications for Systems Operating at 125 PSIG and Less: Use according to the following:

1 Steam Main and Drip Legs: Inverted-bucket traps.
2 Steam Main and Drip Legs: Thermodynamic traps.

R. Install steam traps in accessible locations and within 48 inches of connected equipment.

1. Install gate valve, strainer, and union upstream of each trap; install union, check valve, and gate valve downstream from each trap; unless otherwise indicated.

3.6 IDENTIFICATION INSTALLATION

A. Install continuous plastic underground warning tapes during back-filling of trenches for underground steam distribution piping. Locate 6 to 8 inches below finished grade, directly over piping. Refer to Division 2 Section "Earthwork" for warning-tape materials and devices and their installation.

B. Install pipe markers on aboveground steam distribution piping after pipe insulation has been installed. Refer to Division 2 Section "Utility Materials" for identification materials and devices and their installation.

3.7 FIELD QUALITY CONTROL

A. Prepare buried piping for testing according to manufacturer’s recommendations, and as follows:

1 Leave joints, including welds, uninsulated and exposed for examination during test.
2 Isolate equipment. Do not subject equipment to test pressure.
3 Install relief valve set at pressure not more than one-third higher than test pressure.

B. Test buried piping as follows:

1 Use ambient temperature water. Where there is risk of freezing, air or compatible liquid may be used.
2 Use vents installed at high points to release trapped air while filling system. Use drip legs installed at low points for complete

removal of liquid.

3 Subject piping system to hydrostatic test pressure that is not less than 1.5 times design pressure.

4 After hydrostatic test pressure has been applied for 4 hours, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components as appropriate, and repeat hydrostatic test until there are no leaks.

5 Prepare a written report of testing.

3.8 CLEANING

A. Inspect finish of exposed, steam and condensate piping, including outlets, valves, specialties, and devices, after installation is complete. Remove burrs, dirt, and debris. Repair damaged finishes including chips, scratches, and abrasions.

B. Clean and flush steam and condensate piping. Remove, clean, and replace strainer screens.

3.9 COMMISSIONING

A. Open valves to fully open position.

3.10 BARE-PIPE SYSTEM SCHEDULE

A. Steam Piping Materials and Joining Method: Include the following:

1 Pipe/Tube: Steel pipe.
2 Fittings: Steel welding.
3 Joining Method: Welding.

B. Condensate Piping Materials and Joining Method: Include the following:

1 Pipe/Tube: Steel pipe.
2 Fittings: Steel welding.
3 Joining Method: Welding.

END OF SECTION 15170

SECTION 15181 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:

1. Hot-water heating piping.
2. Chilled-water piping.
3. Makeup-water piping.
4. Condensate-drain piping.
5. Blowdown-drain piping.
6. Air-vent piping.
7. Safety-valve-inlet and -outlet piping.

B. Related Sections include the following:

1. Division 15 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.

1.3 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:

1. Hot-Water Heating Piping: 125 psig at 225E F.
2. Chilled-Water Piping: 125 psig at 100E F.
3. Makeup-Water Piping: 125 psig at 100E F
4. Condensate-Drain Piping: 100E F.
5. Blowdown-Drain Piping: 200E F.
6. Air-Vent Piping: Equal to the pressure of the piping system to which it is attached.
7. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

1.4 SUBMITTALS

A. Product Data: For each type of the following:

1. 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. Chemical treatment.
4. Hydronic specialties.

B. Welding certificates.

C. Qualification Data: For Installer.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in operation, and maintenance manuals.

F. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. 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.

1.6 EXTRA MATERIALS

A. Water-Treatment Chemicals: Furnish enough chemicals for initial system startup and for preventive maintenance for one year from date of Substantial Completion. Hot Water system only.

B. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: Type L.

B. Wrought-Copper Fittings: ASME B16.22.

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

a. Anvil International, Inc.
b. S. P. Fittings; a division of Star Pipe Products.
c. Victaulic Company of America.
d. Prior approved equal.

C. Wrought-Copper Unions: ASME B16.22.

2.2 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 3 "Piping Applications" Article.

C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 3 "Piping Applications" Article.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 "Piping Applications" Article.

E. 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 Part 3 "Piping Applications" Article.

F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

G. 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.

H. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.3 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, maximum thickness unless thickness or specific material is indicated.

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, 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 D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

F. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.4 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper-alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions:

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

a. Capitol Manufacturing Company.
b. Central Plastics Company.
c. Hart Industries International, Inc.
d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
e. Zurn Plumbing Products Group; AquaSpec Commercial Products Division.
f. Prior approved equal.

2. Factory-fabricated union assembly, for minimum working pressure at.

D. Dielectric Flanges:

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

    a. Capitol Manufacturing Company.
    b. Central Plastics Company.
    c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
    d. Prior approved equal.

2. Factory-fabricated companion-flange assembly, for minimum working pressure as required to suit system pressures.

2.5 VALVES

A. Gate, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 15 Section "Valves."

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 15 Section "HVAC Instrumentation and Controls."

C. Bronze, Calibrated-Orifice, Balancing Valves:

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

    a. Armstrong Pumps, Inc.
    b. Bell & Gossett Domestic Pump; a division of ITT Industries.
    c. Flow Design Inc.
    d. Griswold Controls.
    e. Taco.
    f. Prior Approved Equal

2. Body: Bronze, ball or plug type with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Plug: Resin.
5. Seat: PTFE.
6. End Connections: Threaded or socket.
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.
10. Maximum Operating Temperature: .

D. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:

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

    a. Armstrong Pumps, Inc.
    b. Bell & Gossett Domestic Pump; a division of ITT Industries.
    c. Flow Design Inc.

d. Griswold Controls.
e. Taco.
f. Tour & Andersson; available through Victaulic Company of America.
g. Prior approved equal.

2. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Stem Seals: EPDM O-rings.
5. Disc: Glass and carbon-filled PTFE.
6. Seat: PTFE.
7. End Connections: Flanged or grooved.
8. Pressure Gage Connections: Integral seals for portable differential pressure meter.
9. Handle Style: Lever, with memory stop to retain set position.
10. CWP Rating: Minimum.
11. Maximum Operating Temperature: .

E. Diaphragm-Operated, Pressure-Reducing Valves:

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

a. Bell & Gossett Domestic Pump; a division of ITT Industries.
b. Amtrol, Inc.
c. Armstrong Pumps, Inc.
d. Conbraco Industries, Inc.
e. Spence Engineering Company, Inc.
f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
g. Prior approved equal.

2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Low inlet-pressure check valve.
8. Inlet Strainer: , removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

F. Diaphragm-Operated Safety Valves:

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

a. Bell & Gossett Domestic Pump; a division of ITT Industries.
b. Amtrol, Inc.
c. Armstrong Pumps, Inc.
d. Conbraco Industries, Inc.

e. Spence Engineering Company, Inc.
f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
g. Prior approved equal. .

2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Wetted, Internal Work Parts: Brass and rubber.
8. Inlet Strainer: , removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. 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.

2.6 AIR CONTROL DEVICES

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

1. Bell & Gossett Domestic Pump; a division of ITT Industries.
2. Amtrol, Inc.
3. Armstrong Pumps, Inc.
4. Taco.
5. Prior approved equal.

B. 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.
7. Maximum Operating Temperature: 225 deg F.

C. 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.

D. Diaphragm Bladder-Type Expansion Tanks:

1. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature. Factory test with taps fabricated and supports installed and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Diaphragm: 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.

E. 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.

2.7 CHEMICAL TREATMENT

A. Bypass Chemical Feeder: For heating hot water only. Welded steel construction; working pressure; 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.

B. Propylene Glycol: For chilled water system industrial grade with corrosion inhibitors and environmental-stabilizer additives for mixing with water in systems indicated to contain antifreeze or glycol solutions.

C. Chemical Treatment shall be provided by Snow College approved water treatment service organization, which is currently Powers Engineering.

2.8 HYDRONIC PIPING SPECIALTIES

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: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

B. 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 PIPING APPLICATIONS

A. Hot-water heating piping, aboveground, 2 inch and smaller, shall be the following:

1. Type L, hard drawn-temper copper tubing, wrought-copper fittings, and soldered or screwed joints.
2. Schedule 40 steel pipe; Class 125, cast-iron fittings; cast-iron flanges and flange fittings; and threaded joints.

B. Hot-water heating piping, aboveground, 2-1/2 inch and larger, shall be the following:

1. Type L, hard drawn-temper copper tubing, wrought-copper fittings, and soldered or screwed joints.
2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

C. Chilled-water piping, aboveground, 2” and smaller, shall be the following:

1. Type L, hard drawn-temper copper tubing, wrought-copper fittings, and soldered or screwed joints.
2. Schedule 40 steel pipe; Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.

D. Chilled-water piping, aboveground, 2 1/2” and larger shall be the following:

1. Type L, Hard drawn-temper copper tubing, wrought-copper fittings, and soldered or screwed joints.
2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

E. Chilled-water piping installed belowground and within slabs shall be the following:
1. See section 15170.

F. Makeup-water piping installed aboveground shall be the following:

1. Type L, Hard drawn-temper copper tubing, wrought-copper fittings, and soldered or screwed joints.

G. Condensate-Drain Piping:

1. Type C, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
2. PVC piping at gas fired condensing appliances.

H. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

I. Air-Vent Piping:

1. Inlet: Same as service.
2. Outlet: Type, annealed-temper copper tubing with soldered or flared joints.

J. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods.

3.2 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 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; and 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.

3.3 PIPING INSTALLATIONS

A. Design/build drawings shall indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping at right angles and 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, ball valve, and short 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 0.1 percent upward in direction of flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

P. Install valves according to Division 15 Section "Valves."

Q. Install unions in piping, and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install flanges in piping, 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

S. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install nipple and ball valve in blowdown connection of strainers 2-1/2 inch and larger. Match size of strainer blowoff connection for strainers smaller than 2 inch.

T. Install expansion loops, anchors, and pipe alignment guides as specified in Division 15 Section "Pipe Expansion Fittings and Loops."

U. Identify piping as specified in Division 15 Section "Mechanical Identification."

3.4 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Division 15 Section "Hangers and Supports." Comply with the following requirements for maximum spacing of supports.

B. Seismic restraints are specified in Division 15 Section "Mechanical Vibration and Seismic Controls."

C. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping.
2. Adjustable roller hangers and spring hangers for steam piping horizontal piping.
3. Pipe Roller: MSS SP-58, Type 44 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.

D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 7 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 7 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
5. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
6. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.
7. NPS 4: Maximum span, 14 feet; minimum rod size, 1/2 inch.
8. NPS 6: Maximum span, 17 feet; minimum rod size, 1/2 inch.
9. NPS 8: Maximum span, 19 feet; minimum rod size, 5/8 inch.

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 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
6. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.

F. Support vertical runs at roof, at each floor, and at intervals between floors.

3.5 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 15 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. 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.

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 D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "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 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. 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 tangential air separator in pump suction. Install blowdown piping with gate or full-port ball valve; extend full size to nearest floor drain.

E. Install bypass chemical feeders in hot water heating hydronic system where indicated, in upright position with top of funnel not more than above the floor. Install feeder in minimum bypass line, from main with full-size, full-port, ball valve in the main between bypass connections. Install pipe from chemical feeder drain, to nearest equipment drain and include a full-size, full-port, ball valve.

F. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.

1. Install tank fittings that are shipped loose.

2. Support tank from floor with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.

G. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system Project requirements.

3.7 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 ball 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 according to Division 15 Section "Meters and Gages."

3.8 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: Hot water system only.

B. Fill chilled and hot water systems 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. Circulate for an additional 8 hours, drain, clean strainer screens and refill with fresh water.

C. Add initial chemical treatment to hot water system and maintain water quality in ranges recommended by WTC for the first year of operation.

D. Fill systems indicated to have antifreeze or glycol solutions with the following concentrations:

1. Hydronic Piping Systems: Minimum 30 percent propylene glycol.

3.9 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.

3. 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.
4. 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. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. 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 "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 6 hours, 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 the boilers, chiller, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION 15181

SECTION 15182 - STEAM AND CONDENSATE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following for LP and HP steam and condensate piping:

1. Pipe and fittings.
2. Strainers.
3. Safety valves.
4. Pressure-reducing valves.
5. Steam traps.
6. Thermostatic air vents and vacuum breakers.
7. Steam and condensate meters.

1.3 DEFINITIONS

A. HP Systems: High-pressure piping operating at more than 15 psig as required by ASME B31.1.

B. LP Systems: Low-pressure piping operating at 15 psig or less as required by ASME B31.9.

1.4 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures:

1. HP Steam Piping: 150 psig
2. LP Steam Piping: 30 psig
3. Condensate Piping: 30 psig at 250 deg F.
4. Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.
5. Safety-Valve-Inlet and -Outlet Piping: Equal to pressure of the piping system to which it is attached.

1.5 SUBMITTALS

A. Product Data: For each type of the following:

1. Pressure-reducing and safety valve.
2. Steam trap.
3. Air vent and vacuum breaker.
4. Meter.

B. Qualification Data: For Installer.

C. Welding certificates.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For valves, safety valves, pressure-reducing valves, steam traps, air vents, vacuum breakers, and meters to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code - Steel."

B. Pipe Welding: Qualify processes and operators according to the following:

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. ASME Compliance: Comply with ASME B31.1, "Power Piping" and ASME B31.9, "Building Services Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.

PART 2 - PRODUCTS

2.1 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, plain ends, Type, Grade, and Schedule as indicated in Part 3 piping applications articles.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 150 and 300 as indicated in Part 3 piping applications articles.

C. Malleable-Iron Threaded Fittings: ASME B16.3; Classes 150 and 300 as indicated in Part 3 piping applications articles.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 piping applications articles.

E. Cast-Iron Threaded Flanges and Flanged Fittings: ASME B16.1, Classes 125 and 250 as indicated in Part 3 piping applications articles; raised ground face, and bolt holes spot faced.

F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

G. Wrought-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.

H. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, black steel of same Type, Grade, and Schedule as pipe in which installed.

2.2 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 thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 150, 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. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

D. Welding Materials: Comply with Section II, Part C, of ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

2.3 VALVES

A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 15 Section "Valves."

2.4 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 strainers NPS 2 and smaller; flanged ends for strainers NPS 2-1/2 and larger.
3. Strainer Screen: Stainless-steel, 20 mesh strainer, and perforated stainless-steel basket with 50 percent free area.
4. Tapped blowoff plug.
5. CWP Rating: 250-psig working steam pressure.

2.5 SAFETY VALVES

A. Bronze or Brass Safety Valves:

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

   a. Armstrong International, Inc.
   b. Kunkle Valve; a Tyco International Ltd. Company.
   c. Spirax Sarco, Inc.
   d. Watts Water Technologies, Inc.
   e. Prior approved equal.

2. Disc Material: Forged copper alloy.
3. End Connections: Threaded inlet and outlet.
4. Spring: Fully enclosed steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
5. Pressure Class: 250.
6. Drip-Pan Elbow: Cast iron and having threaded inlet and outlet with threads complying with ASME B1.20.1.
7. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

B. Cast-Iron Safety Valves:

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

   a. Armstrong International, Inc.
   b. Kunkle Valve; a Tyco International Ltd. Company.
   c. Spirax Sarco, Inc.
   d. Watts Water Technologies, Inc.
   e. Prior approved equal.

2. Disc Material: Forged copper alloy with bronze nozzle.
3. End Connections: Raised-face flanged inlet and threaded or flanged outlet connections.
4. Spring: Fully enclosed cadmium-plated steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
5. Pressure Class: 250.
6. Drip-Pan Elbow: Cast iron and having threaded inlet, outlet, and drain, with threads complying with ASME B1.20.1.

7. Exhaust Head: Cast iron and having threaded inlet and drain, with threads complying with ASME B1.20.1.
8. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

2.6 PRESSURE-REDUCING VALVES

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

1. Hoffman Specialty; Division of ITT Industries.
2. Spence Engineering Company, Inc.
3. Spirax Sarco, Inc.
4. Prior approved equal.

B. Size, Capacity, and Pressure Rating: Factory set for inlet and outlet pressures indicated.

C. Description: Pilot-actuated, diaphragm type, with adjustable pressure range and positive shutoff.

D. Body: Cast iron.

E. End Connections: Threaded connections for valves NPS 2 and smaller and flanged connections for valves NPS 2-1/2 and larger.

F. Trim: Hardened stainless steel.

G. Head and Seat: Replaceable, main head stem guide fitted with flushing and pressure-arresting device cover over pilot diaphragm.

H. Gaskets: Non-asbestos materials.

2.7 STEAM TRAPS

A. Float and Thermostatic Traps:

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

a. Armstrong International, Inc.
b. Barnes & Jones, Inc.
c. Dunham-Bush, Inc.
d. Hoffman Specialty; Division of ITT Industries.
e. Spirax Sarco, Inc.
f. Sterling.
g. Prior approved equal.

2. Body and Bolted Cap: ASTM A 126, cast iron.

3. End Connections: Threaded.
4. Float Mechanism: Replaceable, stainless steel.
5. Head and Seat: Hardened stainless steel.
6. Trap Type: Balanced pressure.
7. Thermostatic Bellows: Stainless steel or monel.
8. Thermostatic air vent capable of withstanding 45 deg F of superheat and resisting water hammer without sustaining damage.
9. Vacuum Breaker: Thermostatic with phosphor bronze bellows, and stainless steel cage, valve, and seat.
10. Maximum Operating Pressure: 125 psig.

B. Inverted Bucket Traps:

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

   a. Armstrong International, Inc.
   b. Barnes & Jones, Inc.
   c. Dunham-Bush, Inc.
   d. Hoffman Specialty; Division of ITT Industries.
   e. Spirax Sarco, Inc.
   f. Sterling.
   g. Prior approved equal.

2. Body and Cap: Cast iron.
3. End Connections: Threaded.
4. Head and Seat: Stainless steel.
5. Valve Retainer, Lever, and Guide Pin Assembly: Stainless steel.
6. Bucket: Brass or stainless steel.
7. Strainer: Integral stainless-steel inlet strainer within the trap body.
8. Air Vent: Stainless-steel thermostatic vent.
9. Pressure Rating: 250 psig.

2.8 VACUUM BREAKERS

A. Vacuum Breakers:

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

   a. Armstrong International, Inc.
   b. Dunham-Bush, Inc.
   c. Hoffman Specialty; Division of ITT Industries.
   d. Johnson Corporation (The).
   e. Spirax Sarco, Inc.
   f. Prior approved equal.

2. Body: Cast iron, bronze, or stainless steel.
3. End Connections: Threaded.
4. Sealing Ball, Retainer, Spring, and Screen: Stainless steel.

5. O-ring Seal: EPR.
6. Pressure Rating: 125 psig.
7. Maximum Temperature Rating: 350 deg F.

2.9 CONDENSATE METERS

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

1. Central Station Steam Co.
2. Lincoln Meter Company.
3. Prior approved equal.

B. Body: Cast iron, bronze, or brass.

C. Turbine: Copper, brass, or stainless steel.

D. Connections: Threaded for NPS 2 and smaller and flanged for NPS 2-1/2.

E. Totalizer: Meters shall have a microprocessor to display flow, flow rate, time, and date; alarms for high and low flow rate, pressure, and temperature.

1. Computer shall have 4- to 20-mA or 2- to 10-volt output for temperature, pressure, and contact closure for flow increments.
2. Independent timers to store four peak flow rates and total flow.
3. Interface compatible with central workstation specified in Division 15 Section "HVAC Instrumentation and Controls."
4. Microprocessor Enclosure: NEMA 250, Type 4.

F. Maximum Temperature Rating: 250 deg F.

PART 3 - EXECUTION

3.1 LP STEAM PIPING APPLICATIONS

A. LP Steam Piping, NPS 2 and Smaller: Schedule 40, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

B. LP Steam Piping, NPS 2-1/2 through NPS 12: Schedule 40, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

C. Condensate piping above grade, NPS 2 and smaller, shall be the following:

1. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

D. Condensate piping above grade, NPS 2-1/2 and larger, shall be the following:

1. Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

E. Condensate piping below grade, NPS 2 and smaller, shall be either of the following:

1. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

F. Condensate piping below grade, NPS 2-1/2 and larger, shall be either of the following:

1. Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

3.2 HP STEAM PIPING APPLICATIONS

A. HP Steam Piping, NPS 2 and Smaller: Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

B. HP Steam Piping, NPS 2-1/2 through NPS 12: Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

C. Condensate piping above grade, NPS 2 and smaller, shall be the following:

1. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

D. Condensate piping above grade, NPS 2-1/2 and larger, shall be the following:

1. Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

E. Condensate piping below grade, NPS 2 and smaller, shall be the following:

1. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

F. Condensate piping below grade, NPS 2-1/2 and larger, shall be either of the following:

1. Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

3.3 ANCILLARY PIPING APPLICATIONS

A. Vacuum-Breaker Piping: Outlet, same as service where installed.

B. Safety-Valve-Inlet and -Outlet Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

3.4 VALVE APPLICATIONS

A. Install shutoff duty valves at branch connections to steam supply mains, at steam supply connections to equipment, and at the inlet and outlet of steam traps.

B. Install safety valves on pressure-reducing stations and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to nearest floor drain. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

3.5 PIPING INSTALLATION

A. Design/build drawing shall indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping at right angles and 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 free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Install piping to allow application of insulation.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

K. Install drains, consisting of a tee fitting, NPS 3/4 full port-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.

L. Install steam supply piping at a minimum uniform grade of 0.2 percent downward in direction of steam flow.

M. Install condensate return piping at a minimum uniform grade of 0.4 percent downward in direction of condensate flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side down.

O. Install branch connections to mains with the branch connected to top of main pipe.

P. Install valves according to Division 15 Section "Valves."

Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

S. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install NPS 3/4 nipple and full port ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

T. Install expansion loops, anchors, and pipe alignment guides as specified in Division 15 Section "Pipe Expansion Fittings and Loops."

U. Identify piping as specified in Division 15 Section "Mechanical Identification."

V. Install drip legs at low points and natural drainage points such as ends of mains, bottoms of risers, and ahead of pressure regulators, and control valves.

1. On straight runs with no natural drainage points, install drip legs at intervals not exceeding 150 feet.
2. Size drip legs same size as main. In steam mains NPS 6 and larger, drip leg size can be reduced to 50% of main diameter but to no less than NPS 4.

3.6 STEAM-TRAP INSTALLATION

A. Install steam traps in accessible locations as close as possible to connected equipment.

B. Install full-port ball valve, strainer, and union upstream from trap; install union, check valve, and full-port ball valve downstream from trap unless otherwise indicated.

3.7 PRESSURE-REDUCING VALVE INSTALLATION

A. Install pressure-reducing valves in accessible location for maintenance and inspection.

B. Install bypass piping around pressure-reducing valves, with globe valve equal in size to area of pressure-reducing valve seat ring, unless otherwise indicated.

C. Install gate valves on both sides of pressure-reducing valves.

D. Install unions or flanges on both sides of pressure-reducing valves having threaded- or flanged-end connections respectively.

E. Install pressure gages on both sides of pressure-reducing valves before and after the bypass connection according to Division 15 Section "Meters and Gages."

F. Install strainers upstream of pressure-reducing valve.

G. Install safety valve downstream from pressure-reducing valve station.

3.8 CONDENSATE METER INSTALLATION

A. Install meters with lengths of straight pipe upstream and downstream according to steam meter manufacturer's instructions.

B. Provide data acquisition wiring. Refer to Division 15 Section "HVAC Instrumentation and Controls."

3.9 SAFETY VALVE INSTALLATION

A. Install safety valves according to ASME B31.1, "Power Piping." and ASME B31.9, "Building Services Piping."

B. Pipe safety-valve discharge without valves to atmosphere outside the building.

C. Install drip-pan elbow fitting adjacent to safety valve and pipe drain connection to nearest floor drain.

3.10 HANGERS AND SUPPORTS

A. Install hangers and supports according to Division 15 Section "Hangers and Supports." Comply with requirements below for maximum spacing.

B. Seismic restraints are specified in Division 15 Section "Mechanical Vibration and Seismic Controls."

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. Spring hangers to support vertical runs.

D. Install hangers with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 9 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 9 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/2: Maximum span, 12 feet; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 13 feet; minimum rod size, 3/8 inch.
5. NPS 2-1/2: Maximum span, 14 feet; minimum rod size, 3/8 inch.

6. NPS 3: Maximum span, 15 feet; minimum rod size, 3/8 inch.
7. NPS 4: Maximum span, 17 feet; minimum rod size, 1/2 inch.
8. NPS 6: Maximum span, 21 feet; minimum rod size, 1/2 inch.
9. NPS 8: Maximum span, 24 feet; minimum rod size, 5/8 inch.

E. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.11 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 15 Sections specifying piping systems.

B. Bevel plain ends of steel pipe.

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. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

E. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.12 TERMINAL EQUIPMENT CONNECTIONS

A. Size for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install traps and 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 drip leg at convertor and coil outlets to tank heaters.

E. Install a drip leg at coil outlet.

3.13 FIELD QUALITY CONTROL

A. Prepare steam and condensate piping according to ASME B31.9, "Building Services Piping," and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Flush system with clean water. Clean strainers.
3. 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.

B. Perform the following tests on steam and condensate piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the 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.
3. After hydrostatic test pressure has been applied for at least 6 hours, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.

C. Prepare written report of testing.

END OF SECTION 15182

SECTION 15185 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Close-coupled, in-line centrifugal pumps.
2. Close-coupled, end-suction centrifugal pumps.
3. Separately coupled, base-mounted, end-suction centrifugal pumps.

1.3 DEFINITIONS

A. Buna-N: Nitrile rubber.

B. EPT: Ethylene propylene terpolymer.

1.4 SUBMITTALS

A. Product Data: 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.

B. Operation and Maintenance Data: For pumps to include in operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain hydronic pumps through one source from a single manufacturer.

B. Product Options: Design/build contract drawings shall indicate size, profiles, and dimensional requirements of hydronic. Refer to Division 1 Section "Product Requirements."

C. 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.

D. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

B. Store pumps in dry location.

C. Retain protective covers for flanges and protective coatings during storage.

D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

E. Comply with pump manufacturer's written rigging instructions.

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 Division 3.

1.8 EXTRA MATERIALS

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. Mechanical Seals: One mechanical seal for each pump.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers:

1. Bell & Gossett; Div. of ITT Industries.

2. Armstrong Pumps Inc.
3. Prior approved equal.

B. 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. Rate pump for 125-psig minimum working pressure and a continuous water temperature of 200 deg F.

C. Pump Construction:

1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, and threaded companion-flange or union end connections.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.
5. Packing Seal: Stuffing box, with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
6. Pump Bearings: Permanently lubricated ball bearings.

D. Motor: Single speed, with permanently lubricated ball bearings, unless otherwise indicated; and rigidly mounted to pump casing. Comply with requirements in Division 15 Section "Motors."

E. Capacities and Characteristics: See Drawings.

2.3 CLOSE-COUPLED, END-SUCTION CENTRIFUGAL PUMPS

A. Manufacturers:

1. Armstrong Pumps Inc.
2. Bell & Gossett; Div. of ITT Industries.
3. Prior approved equal.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally. Rate pump for 125-psig minimum working pressure and a continuous water temperature of 225 deg F.

C. Pump Construction:

1. Casing: Radially split, cast iron, with replaceable bronze wear rings, drain plug at bottom and air vent at top of volute, threaded gage tappings at inlet and outlet, 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. Trim impeller to match specified performance.
3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.
5. Pump Bearings: Permanently lubricated ball bearings.
6. Motor: Variable speed, with permanently lubricated ball bearings, unless otherwise indicated; rigidly mounted to pump casing with integral pump support. Comply with requirements in Division 15 Section "Motors."

D. Capacities and Characteristics: Provided by design/build team.

2.4 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

A. Manufacturers:

1. Bell & Gossett; Div. of ITT Industries.
2. Armstrong Pumps Inc.
3. Prior approved equal.

B. 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. Rate pump for 125-psig minimum working pressure and a continuous water temperature of 225 deg F.

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 connections. Provide integral mount on volute to support the casing, and 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. Trim impeller to match specified performance.
3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket.
5. Packing Seal: Stuffing box, with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
6. Pump Bearings: Grease-lubricated ball bearings contained 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 EPDM coupling sleeve for variable-speed applications.

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: Variable speed, with permanently lubricated ball bearings, unless otherwise indicated; secured to mounting frame, with adjustable alignment. Comply with requirements in Division 15 Section "Motors."

H. Capacities and Characteristics: See Drawings.

2.5 PUMP SPECIALTY FITTINGS

A. Suction Diffuser: Angle pattern, 175-psig pressure rating, cast-iron body and end cap, pump-inlet fitting; with bronze startup and bronze or stainless-steel permanent strainers; bronze or stainless-steel straightening vanes; drain plug; and factory-fabricated support.

B. Triple-Duty Valve: Angle or straight pattern, 175-psig pressure rating, cast -iron body, pump-discharge fitting; with drain plug and bronze-fitted shutoff, balancing, and check valve features. Brass gage ports with integral check valve, and orifice for flow measurement.

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 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 CONCRETE BASES

A. Install concrete bases of dimensions indicated for pumps and controllers. Refer to Division 15 Section "Basic Mechanical Materials and Methods."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Cast-in-place concrete materials and placement requirements are specified in Division 3.

3.3 PUMP INSTALLATION

A. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

B. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

C. Install continuous-thread hanger rods and spring hangers of sufficient size to support pump weight. Vibration isolation devices are specified in Division 15 Section "Mechanical Vibration and Seismic Controls." Fabricate brackets or supports as required. Hanger and support materials are specified in Division 15 Section "Hangers and Supports."

D. Suspend vertically mounted, in-line centrifugal pumps independent of piping. Install pumps with motor and pump shafts vertical. Use continuous-thread hanger rods and spring hangers of sufficient size to support pump weight. Vibration isolation devices are specified in Division 15 Section "Mechanical Vibration and Seismic Controls." Hanger and support materials are specified in Division 15 Section "Hangers and Supports."

E. Set base-mounted pumps on concrete foundation. Disconnect coupling before setting. Do not reconnect couplings until alignment procedure is complete.

1. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2 inches between pump base and foundation for grouting.
2. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.

3.4 ALIGNMENT

A. Align pump and motor shafts and piping connections after setting on foundation, grout has been set and foundation bolts have been tightened, and piping connections have been made.

B. Comply with pump and coupling manufacturers' written instructions.

C. Adjust pump and motor shafts for angular and offset alignment.

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.

3.5 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings shall indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

E. Install check valve and throttling valve or triple-duty valve on discharge side of pumps.

F. Install suction diffuser and shutoff valve on suction side of pumps.

G. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

H. Install pressure gages on pump suction and discharge, at integral pressure-gage tapping.

I. Install electrical connections for power, controls, and devices.

J. Ground equipment according to Division 16 Section "Grounding and Bonding."

K. Connect wiring according to Division 16 Section "Conductors and Cables."

3.6 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.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps. Refer to Division 1 Section " Demonstration and Training."

END OF SECTION 15185

SECTION 15186 - STEAM CONDENSATE PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes electric-driven steam condensate pumps.

1.3 SUBMITTALS

A. Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated. Indicate pump's operating point on curves. Include receiver capacity and material.

B. Operation and Maintenance Data: For pumps to include in operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain steam condensate pumps through one source from a single manufacturer.

B. Product Options: Design/build drawings shall indicate size, profiles, and dimensional requirements of steam condensate pumps and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

C. 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.

D. ASME Compliance: Fabricate and label steam condensate pumps to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

B. Store steam condensate pumps in dry location.

C. Retain protective covers for flanges and protective coatings during storage.

D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

E. Comply with pump manufacturer's written rigging instructions.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 ELECTRIC-DRIVEN STEAM CONDENSATE PUMPS

A. Description: Factory-fabricated, packaged, electric-driven pumps; with receiver, pump(s), controls, and accessories suitable for operation with steam condensate.

B. Configuration: Duplex floor-mounting pumps with receiver and float switches; rated to pump minimum 210 deg F steam condensate.

1. Manufacturers:

a. Aurora Pump; Division of Pentair Pump Group.
b. Spence Engineering Company, Inc.; Division of Circor International, Inc.
c. Spirax Sarco, Inc.
d. Prior approved equal.

2. Receiver: Floor-mounting, close-grained cast iron or welded steel; externally adjustable float switches; with water-level gage, steam condensate thermometer, discharge-pressure gage for each pump, bronze gate valves between receiver and pumps, flanges for pump mounting, and lifting eyebolts.
3. Inlet Strainer: Cast iron with self-cleaning bronze screen, dirt pocket, and cleanout plug on receiver inlet.

4. Pumps: Centrifugal, close coupled, vertical design, permanently aligned, and bronze fitted; with replaceable bronze case rings, stainless-steel shafts, and mechanical seals; mounted on receiver flanges.
5. Control Panel: NEMA 250, Type 2 enclosure with hinged door and grounding lug, mounted on pump; factory wired for single external electrical connection; and with the following components within cabinet:

    a. Motor controller for each pump.
    b. Electrical pump alternator to operate pumps in lead-lag sequence and allow both pumps to operate on receiver high level.
    c. Manual lead-lag control to override electrical pump alternator to manually select the lead pump.
    d. Momentary contact "TEST" push button on cover for each pump.
    e. Numbered terminal strip.
    f. Disconnect switch.
    g. Fused transformer for control circuit.

6. Capacities and Characteristics: Shall be on design/build drawings.

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 work.

B. Examine rough installation of steam condensate piping.

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

3.2 INSTALLATION

A. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.

B. Install thermometers and pressure gages.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install check valve, gate valve, and globe valve at pump discharge connections for each electric-driven pump.

C. Pipe drain to nearest floor drain for overflow and drain piping connections.

D. Install full-size vent piping to outdoors, terminating in 180-degree elbow at point above highest steam system connection or as indicated.

E. Ground equipment according to Division 16 Section "Grounding and Bonding."

F. Connect wiring according to Division 16 Section "Conductors and Cables."

3.4 STARTUP SERVICE

A. Verify that steam condensate pumps are installed and connected according to the Contract Documents.

B. Complete installation and startup checks according to manufacturer's written instructions.

C. Clean strainers.

D. Set steam condensate pump controls.

E. Set pump controls for automatic start, stop, and alarm operation.

F. Perform the following preventive maintenance operations and checks before starting:

1. Set float switches to operate at proper levels.
2. Check motors for proper rotation.
3. Test pump controls and demonstrate compliance with requirements.
4. Replace damaged or malfunctioning pump controls and equipment.
5. Verify that pump controls are correct for required application.

G. Start steam condensate pumps according to manufacturer's written startup instructions.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain steam condensate pumps. Refer to Division 1 Section " Demonstration and Training."

END OF SECTION 15186

SECTION 15195 - 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 1 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. Valves.
5. Pressure regulators.
6. Mechanical sleeve seals.

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, crawlspaces, 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 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig minimum unless otherwise indicated.

1.5 SUBMITTALS

A. Product Data: 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.
4. Pressure regulators. Indicate pressure ratings and capacities.
5. Dielectric fittings.
6. Mechanical sleeve seals.
7. Escutcheons.

B. Welding certificates.

C. Field quality-control reports.

D. Operation and Maintenance Data: For pressure regulators to include in emergency, operation, and maintenance manuals.

1.6 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.

1.7 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.

1.8 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: 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. Notify Owner no fewer than two days in advance of proposed interruption of natural-gas service.
2. Do not proceed with interruption of natural-gas service without Owner's written permission.

1.9 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 Division 8 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 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.

5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.

   a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

B. Corrugated, Stainless-Steel Tubing: Comply with ANSI/IAS LC 1.

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. OmegaFlex, Inc.
    b. Parker Hannifin Corporation; Parflex Division.
    c. Titeflex.
    d. Tru-Flex Metal Hose Corp.
    e. Prior approved equal.

2. Tubing: ASTM A 240/A 240M, corrugated, Series 300 stainless steel.
3. Coating: PE with flame retardant.

    a. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 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.

4. Fittings: Copper-alloy mechanical fittings with ends made to fit and listed for use with corrugated stainless-steel tubing and capable of metal-to-metal seal without gaskets. Include brazing socket or threaded ends complying with ASME B1.20.1.
5. Striker Plates: Steel, designed to protect tubing from penetrations.
6. Manifolds: Malleable iron or steel with factory-applied protective coating. Threaded connections shall comply with ASME B1.20.1 for pipe inlet and corrugated tubing outlets.
7. Operating-Pressure Rating: 5 psig.

C. 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.
    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.

5. Plastic Mechanical Couplings,NPS 1-1/2 and Smaller: Capable of joining PE pipe to PE pipe.

   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) Lyall, R. W. & Company, Inc.
      2) Mueller Co.; Gas Products Div.
      3) Perfection Corporation; a subsidiary of American Meter Company.
      4) Prior approved equal..

   b. PE body with molded-in, stainless-steel support ring.
   c. Buna-nitrile seals.
   d. Acetal collets.
   e. Electro-zinc-plated steel stiffener.

6. Plastic Mechanical Couplings,NPS 2 and Larger: Capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.

   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) Lyall, R. W. & Company, Inc.
      2) Mueller Co.; Gas Products Div.
      3) Perfection Corporation; a subsidiary of American Meter Company.
      4) Prior approved equal..

   b. Fiber-reinforced plastic body.
   c. PE body tube.
   d. Buna-nitrile seals.
   e. Acetal collets.
   f. Stainless-steel bolts, nuts, and washers.

7. Steel Mechanical Couplings: Capable of joining plain-end PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.

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) Dresser Piping Specialties; Division of Dresser, Inc.
2) Smith-Blair, Inc.
3) Prior approved equal..

b. Steel flanges and tube with epoxy finish.
c. Buna-nitrile seals.
d. Steel bolts, washers, and nuts.
e. Factory-installed anode for steel-body couplings installed underground.

2.2 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.

2.3 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.

2.4 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. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.

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. BrassCraft Manufacturing Company; a Masco company.
   b. Conbraco Industries, Inc.; Apollo Div.
   c. Lyall, R. W. & Company, Inc.
   d. McDonald, A. Y. Mfg. Co.
   e. Perfection Corporation; a subsidiary of American Meter Company.
   f. Prior approved equal..

2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated brass.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Separate packnut with adjustable-stem packing threaded ends.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

E. PE Ball Valves: Comply with ASME B16.40.

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. Kerotest Manufacturing Corp.
   b. Lyall, R. W. & Company, Inc.
   c. Perfection Corporation; a subsidiary of American Meter Company.
   d. Prior approved equal..

2. Body: PE.
3. Ball: PE.
4. Stem: Acetal.
5. Seats and Seals: Nitrile.
6. Ends: Plain or fusible to match piping.
7. CWP Rating: 80 psig.
8. Operating Temperature: Minus 20 to plus 140 deg F.
9. Operator: Nut or flat head for key operation.
10. Include plastic valve extension.
11. Include tamperproof locking feature for valves where indicated on Drawings.

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.

2.5 EARTHQUAKE VALVES

A. Earthquake Valves: Comply with ASCE 25.

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. Vanguard Valves, Inc.
   b. Safe-T-Quake.
   c. Koso
   d. Trembler Tech
   e. Prior approved equal.

2. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
3. Maximum Operating Pressure: 5 psig.
4. Cast-aluminum body with nickel-plated chrome steel internal parts.
5. Nitrile-rubber valve washer.
6. Sight windows for visual indication of valve position.
7. Threaded end connections complying with ASME B1.20.1.
8. Wall mounting bracket with bubble level indicator.

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. Pressure Regulators: Comply with ANSI Z21.80.

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. Actaris.
   b. American Meter Company.
   c. Fisher Control Valves and Regulators; Division of Emerson Process Management.
   d. Invensys.
   e. Richards Industries; Jordan Valve Div.
   f. Prior approved equal..

2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 100 psig.

2.7 SLEEVES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

2.8 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

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

    a. Advance Products & Systems, Inc.
    b. Calpico Inc.
    c. Metraflex Company (The).
    d. Pipeline Seal and Insulator, Inc.
    e. Link-Seal.
    f. Prior approved equal.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe and sleeve.
3. Pressure Plates: Carbon steel.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one nut and bolt for each sealing element.

2.9 ESCUTCHEONS

A. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to fit around pipe or tube, and OD that completely covers opening.

B. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Escutcheons: With set screw.

    1. Finish: Polished chrome-plated.

D. Split-Casting, Cast-Brass Escutcheons: With concealed hinge and set screw.

    1. Finish: Polished chrome-plated.

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 the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.

C. Comply with the International Fuel Gas Code requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.

B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Division 2 Section "Earthwork" for excavating, trenching, and backfilling.

1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.

C. Install underground, PE, natural-gas piping according to ASTM D 2774.

D. Install fittings for changes in direction and branch connections.

E. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Install steel pipe for sleeves smaller than 6 inches in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.

F. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

H. Install pressure gage upstream and downstream from each service regulator. Pressure gages are specified in Division 15 Section "Meters and Gages."

3.4 INDOOR PIPING INSTALLATION

A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.

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. Install escutcheons at penetrations of interior walls, ceilings, and floors.

1. New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
b. Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
c. Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
d. Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
e. Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated or rough-brass finish.

L. 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 in Division 7 Section "Through-Penetration Firestop Systems."

M. Verify final equipment locations for roughing-in.

N. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

O. 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 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

P. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

Q. 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.

R. 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.

1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
4. 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.

5. 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.

S. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

T. Connect branch piping from top or side of horizontal piping.

U. 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.

V. Do not use natural-gas piping as grounding electrode.

W. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

X. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Division 15 Section "Meters and Gages."

3.5 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper 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 earthquake valves aboveground outside buildings according to listing.

E. Install anode for metallic valves in underground PE piping.

3.6 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:

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. 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.

3.7 HANGER AND SUPPORT INSTALLATION

A. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 15 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

B. Comply with requirements for pipe hangers and supports specified in Division 15 Section "Hangers and Supports."

C. 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.

3.8 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.

3.9 LABELING AND IDENTIFYING

A. Comply with requirements in Division 15 Section "Mechanical Identification" for piping and valve identification.

B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.10 PAINTING

A. Comply with requirements in Division 9 painting Sections 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 (flat).
d. Color: By owner.

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. Intermediate Coat: Interior latex matching topcoat.
c. Topcoat: Interior latex (semigloss).
d. Color: By owner.

D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.11 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Test, inspect, and purge natural gas according to 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.

3.12 OUTDOOR PIPING SCHEDULE

A. 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.

B. Aboveground natural-gas piping shall be the following:

1. Steel pipe with malleable-iron fittings and threaded joints.

3.13 INDOOR PIPING SCHEDULE

A. Aboveground, branch piping shall be the following:
1. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping 2” and larger shall be the following:

1. Steel pipe with wrought-steel fittings and welded joints.

3.14 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 and smaller at service meter shall be the following:

1. One-piece, bronze ball valve with bronze trim.

B. Valves for pipe sizes NPS 2-1/2 and larger at service meter shall be one of the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.
2. Bronze plug valve.
3. Cast-iron, nonlubricated plug valve.

C. Distribution piping valves for pipe sizes NPS 2 and smaller shall be one of the following:

1. One-piece, bronze ball valve with bronze trim.

D. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be one of the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.
2. Bronze plug valve.
3. Cast-iron, lubricated plug valve.

END OF SECTION 15195

SECTION 15410 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following conventional plumbing fixtures and related components:
   1. Faucets for lavatories and sinks.
   2. Lavatories.
   3. Sink Faucets
   4. Sinks.
   5. Flushometers - Urinals
   6. Urinals
   7. Flushometers - Water Closets
   8. Water closets.
   9. Toilet seats.
   10. Protective shielding guards.
   11. Fixture supports.
   12. Disposers.
   13. Service sinks.
   14. Bathtub shower faucets
   15. Bathtubs
   16. Shower faucets

B. Related Sections include the following:
   1. Division 22 Section "Plumbing Specialties" for backflow preventers, floor drains, and specialty fixtures not included in this Section.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

C. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.

D. Cultured Marble: Cast-filled-polymer-plastic material with surface coating.

E. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

F. FRP: Fiberglass-reinforced plastic.

G. PMMA: Polymethyl methacrylate (acrylic) plastic.

H. PVC: Polyvinyl chloride plastic.

I. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

1.4 SUBMITTALS

A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.

B. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation, and maintenance manuals.

C. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.
   1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.

D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

E. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

F. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

G. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
   1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
   2. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
   3. Vitreous-China Fixtures: ASME A112.19.2M.
   4. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.

H. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:
   1. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
   2. Faucets: ASME A112.18.1.
   3. Hose-Connection Vacuum Breakers: ASSE 1011.
   4. Hose-Coupling Threads: ASME B1.20.7.
   5. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
   6. NSF Potable-Water Materials: NSF 61.
   7. Pipe Threads: ASME B1.20.1.
   8. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
   9. Supply Fittings: ASME A112.18.1.
   10. Brass Waste Fittings: ASME A112.18.2.

I. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
   1. Atmospheric Vacuum Breakers: ASSE 1001.
   2. Brass and Copper Supplies: ASME A112.18.1.
   3. Manual-Operation Flushometers: ASSE 1037.
   4. Brass Waste Fittings: ASME A112.18.2.
   5. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.

J. Comply with the following applicable standards and other requirements specified for miscellaneous components:
   1. Disposers: ASSE 1008 and UL 430.
   2. Flexible Water Connectors: ASME A112.18.6.
   3. Floor Drains: ASME A112.6.3.
   4. Hose-Coupling Threads: ASME B1.20.7.
   5. Hot-Water Dispensers: ASSE 1023 and UL 499.
   6. Off-Floor Fixture Supports: ASME A112.6.1M.
   7. Pipe Threads: ASME B1.20.1.
   8. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.6 WARRANTY

A. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace components of whirlpools that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures of unit shell.
      b. Faulty operation of controls, blowers, pumps, heaters, and timers.
      c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Period: One year from date of Substantial Completion.

1.7 EXTRA MATERIALS

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. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
   2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.
   3. Flushometer Valve, Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than 2 of each type.
   4. Provide hinged-top wood or metal box, or individual metal boxes, with separate compartments for each type and size of extra materials listed above.

PART 2 - PRODUCTS

2.1 LAVATORY FAUCETS

A. Public Lavatory Faucets – battery powered, sensor operated:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Chicago Faucets
      b. Sloan
      c. Zurn
      d. Prior approved equal.
   2. Single hole, deck mount, traditional electronic lavatory fitting with dual beam infrared sensor.
   3. Cast brass spout with chrome plate finish.
   4. Provide with 6 V lithium battery integral 12V transformer for hardwired connection to building 120v.
   5. Provide with concealed internal temperature control mixer, with multiple field adjustable modes and ranges.
   6. Provide with 10w flow 0.5gpm aerator.

B. Lavatory Faucets - Housing Units
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Chicago.
      b. Elkay.
      c. T & S Brass and Bronze Works, Inc.
      d. Symmons.
      e. Prior approved equal.

   2. Description: Coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor. Lavatories in housing units shall be integral with solid surface counter top by others.

a. Body Material: Metal construction, polished chrome finish.
b. Finish: Polished chrome plate.
c. Maximum Flow Rate: 0.5 gpm.
d. Single lever ADA faucet.
e. Mounting: Deck, concealed.
f. Spout: Rigid type.
g. Spout Outlet: Aerator.
h. Drain: pop up drain & lift rod.
i. Tempering Device: Thermostatic.

2.2 LAVATORIES

A. Lavatories- Public:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Kohler Co. Kingston K-2007.
b. American Standard Companies, Inc.
c. Eljer.
d. Elkay
e. Zurn.
f. Prior approved equal.
2. Description: Accessible, wall-mounting, vitreous-china fixture.
a. Type: With back.
b. Size: 20 by 18 inches rectangular.
c. Faucet Hole Punching: Single hole 1-1/16”. Coordinate exact size and location with faucet manufacturer.
d. Color: White.
e. Supplies: NPS 3/8 chrome-plated copper with stops.
f. Drain: Grid with offset waste.
1) Location: Near back of bowl.

B. Lavatories, Counter Mounted:

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

a. Commercial Enameling Company.
b. Eljer.
c. Kohler Co.
d. American Standard.
e. Crane.
f. Zurn.
g. Prior approved equal.

2. Description: Accessible Counter-mounting, vitreous-china fixture.

a. Type: Self-rimming.
b. Oval Lavatory Size: 20 by 17 inches.
c. Faucet Hole Punching: Three holes, 4-inch centers.
d. Color: White.

e. Supplies: NPS 3/8 chrome-plated copper with stops.
f. Drain: Grid with offset waste.

1) Location: Near back of bowl.

C. Mixing valve:

1. Valve shall be thermostatic and pressure mixing valve with maximum 5 degree approach temperature.
2. Approved Manufacturers -

a. Powers hydroguard TP or equal by
b. Sloan
c. Prior approved equal

D. Lavatories - Residential Units
1. Description: Two compartment, counter-mounting, stainless-steel commercial sink with backsplash.

a. Overall dimensions: 33”X22”
b. Metal Thickness: 18 gauge.
c. Compartment:

1) Drain: NPS 1-1/2 tailpiece with stopper.

a) Location: Back of compartment.

E. Commercial Sinks, Single Compartment Laundry Sink:

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

a. Elkay. Lustertone or equal by.
b. Just Manufacturing Company.
c. Kohler.
d. Piror approved equal.

2. Description: One- compartment, counter-mounting, stainless-steel commercial sink with backsplash.

a. Overall Dimensions: See drawings.
b. Metal Thickness: 18 gauge.
c. Compartment:

1) Drain: NPS 1-1/2 tailpiece with stopper.

a) Location Back of compartment.

F. Commercial Sinks, Two Compartment ADA Kitchen Sink:

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

    a. Elkay. Lustertone or equal by.
    b. Just Manufacturing Company.
    c. Piror approved equal.

2. Description: Two- compartment, counter-mounting, ADA stainless-steel commercial sink with backsplash.

    a. Overall Dimensions: See drawings.
    b. Metal Thickness: 18 gauge.
    c. Compartment:

        1) Drain: NPS 1-1/2 tailpiece with stopper.

            a) Location Back of compartment.

2.3 SINK FAUCETS

A. Sink Faucets:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Chicago Faucets. 2300-8CP or equal by
    b. Kohler Co.
    c. American Standard Companies, Inc.
    d. Eljer.
    e. Elkay Manufacturing Co.
    f. T&S Brass
2. Description: Kitchen faucet without spray. 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, unless otherwise indicated.
    d. Mixing Valve: Single control.
    e. Mounting: Deck.
    f. Handle(s): Lever.
    g. Spout Type: Swing, solid brass.
    h. Spout Outlet: Aerator.
    i. Drain: Stopper with chain.

2.4 FLUSHOMETERS-URINALS

A. Flushometers, Urinals:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Sloan Valve Company.
    b. Zurn Plumbing Products Group. Z6000 series

c. Prior approved equal.

2. Description: Flushometer for urinal-type fixture. Include brass body with corrosion-resistant internal components, non-hold-open feature, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts.
   a. Internal Design: Diaphragm operation.
   b. Style: Exposed.
   c. Inlet Size: NPS 3/4.
   d. Trip Mechanism: Manual operated lever with an aftermarket external “slide over” battery operated sensor conversion kit.
   e. Consumption: 1/8 gpf.

2.5 URINALS

A. Urinals:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Kohler Co. Dexter K5016 or equal by
      b. American Standard Companies, Inc.
      c. Eljer.
      d. Zurn.
      e. Sloan
      f. Prior approved equal.

   2. Description: Accessible, where indicated on drawings, Wall-mounting, back-outlet, vitreous-china fixture designed for flushometer valve operation.
      a. Type: Blowout with extended shields.
      b. Strainer or Trapway: Open trapway with integral trap.
      c. Design Consumption: 1/8gpf.
      d. Color: White.
      e. Supply Spud Size: NPS 3/4.
      f. Outlet Size: NPS 1-1/2.

2.6 FLUSHOMETERS-WATER CLOSETS

A. Flushometers, Water Closets:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Sloan Valve Company.
      b. Zurn Plumbing Products Group. Z6000 series
      c. Prior approved equal.
   2. Description: Flushometer for water closet fixture. Include brass body with corrosion-resistant internal components, non-hold-open feature, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts.
      a. Internal Design: Diaphragm operation.
      b. Style: Exposed.
      c. Inlet Size: NPS 1”.

d. Trip Mechanism: Manual operated lever with an aftermarket external “slide over” battery operated sensor conversion kit.
e. Consumption: 1. 28 gal./flush.

2.7 WATER CLOSETS

A. Water Closets, Wall Mounted Flush Valve:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Kohler Co. Kingston 4325 or equal by
b. Zurn.
c. American Standard Companies, Inc. AFT Wall Water Saver 2257.103.
d. Eljer.
e. Prior approved equal.
2. Description Accessible, Where indicated on drawings, wall Wall-mounting, back-outlet, vitreous-china fixture designed for flushometer valve operation.
a. Style: Flushometer valve.
1) Bowl Type: Elongated with siphon-jet design.
2) Design Consumption: 1.28 gal./flush.
3) Color: White.
b. Flushometer.

B. Water Closets - Floormounted tank type
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. American Standard Companies, Inc. Cadet3.
b. Eljer.
c. Kohler Co.
d. Zurn.
e. Prior approved equal.
2. Description Accessible, where indicated on drawings, Floor-mounting, back-outlet, vitreous-china fixture designed for gravity-tank operation.
a. Style:
1) Bowl Type: Elongated with siphon-jet design. Include bolt caps matching fixture.
2) Height: Accessible, where indicated on drawings.
3) Design Consumption.
4) Tank: Gravity type with trim. Include cover.
5) Trip Mechanism: Lever-handle actuator.
6) Color: White.
7) Performance: Must have a map test rating of 1000.
8) Design consumption: 1.28gal/flush.

2.8 TOILET SEATS

A. Toilet Seats:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Kohler Co. Lustra K-4650 or equal by.

b. American Standard Companies, Inc.
c. Bemis Manufacturing Company.
d. Centoco Manufacturing Corp.
e. Church Seats.
f. Eljer.
g. Olsonite Corp.
h. Proflo.
i. Sanderson Plumbing Products, Inc.; Beneke Div.
j. Sperzel.

2. Description: Toilet seat for water-closet-type fixture.
   a. Material: Molded, solid plastic.
   b. Configuration: Open front without cover.
   c. Hinge Type: SS, self-sustaining.
   d. Class: Standard commercial.
   e. Color: White.

2.9 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Piping Enclosures:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. TRUEBRO, Inc.
      b. McGuire.
      c. Proflo.
      d. Prior approved equal.
   2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

2.10 FIXTURE SUPPORTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Josam Company.
   2. MIFAB Manufacturing Inc.
   3. Smith, Jay R. Mfg. Co.
   4. Tyler Pipe; Wade Div.
   5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
   6. Zurn Plumbing Products Group; Specification Drainage Operation.
   7. Prior approved equal.

B. Water-Closet Supports:
   1. Description: Combination carrier designed for accessible or standard mounting height as required of wall-mounting, water-closet-type fixture. Include single or double, vertical or horizontal, hub-and-spigot or hubless waste fitting as required for piping arrangement; faceplates; couplings with gaskets; feet; and fixture bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.

C. Urinal Supports:
   1. Description: Type I, urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture for wall-mounting, urinal-type fixture. Include steel uprights with feet.
   2. Accessible-Fixture Support: Include rectangular steel uprights.

D. Lavatory Supports:
   1. Description: Type II, lavatory carrier with concealed arms and tie rod for wall-mounting, lavatory-type fixture. Include steel uprights with feet.
   2. Accessible-Fixture Support: Include rectangular steel uprights.

E. Sink Supports:
   1. Description: Type II, sink carrier with hanger plate, bearing studs, and tie rod for sink-type fixture. Include steel uprights with feet.

2.11 DISPOSERS

A. Disposers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. In-Sink-Erator; a div. of Emerson Electric Co. Badger 3 or equal by.
      b. American Standard Companies, Inc.
      c. Franke Consumer Products, Inc.; Kitchen Systems Div.
      d. KitchenAid.
      e. Maytag Co.
   2. Description: Batch-feed household, food-waste disposer. Include reset button; wall switch; corrosion-resistant chamber with jam-resistant, cutlery- or stainless-steel grinder or shredder; NPS 1-1/2 outlet; quick-mounting, stainless-steel sink flange; antisplash guard; and combination cover/stopper.
      a. Type: Batch-feed household.
      b. Motor: As shown in drawings with overload protection.

2.12 SERVICE SINKS

A. Service Sinks:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Kohler Co. Whitby K-6710 or equal by
      b. American Standard Companies, Inc.
      c. Commercial Enameling Company.
      d. Eljer.
   2. Description: Floor-mounting, enameled, cast-iron fixture with front apron, raised back, and coated, wire rim guard.
      a. Size: 28 by 28 inches.
      b. Color: White.
      c. Faucet: Sink American Standard 8344.111 with threaded spout and48 inch hose and damp or equal by
         1) Eljer.
         2) Kohler.

3) Speakman.
d. Drain: Grid with NPS 2 outlet.

2.13 BATHTUB/SHOWER FAUCETS ADA

A. Bathtub/Shower Faucets:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. American Standard Companies, Inc.
b. Chicago Faucets.
c. Eljer.
d. Kohler Co.
e. Leonard Valve Company.
f. Moen, Inc.
g. Powers; a Watts Industries Co.
h. Symmons Industries, Inc.
i. T & S Brass and Bronze Works, Inc.
j. Zurn
k. T & S Brass and Bronze Works, Inc.
l. Prior approved equal
2. Description: Single-handle thermostatic/pressure-balance valve for bathtub and for shower. Include hot- and cold-water indicators; check stops; tub spout; and shower head, arm, and flange and mounting sidewall. Coordinate faucet inlets with supplies; coordinate outlet with diverter valve.
a. Body Material: Polished brass.
b. Finish: Polished chrome plate.
c. Maximum Flow Rate: 1.5 gpm, unless otherwise indicated.
d. Diverter Valve: Not integral with mixing valve.
e. Mounting: Wall.
f. Bathtub Spout: Chrome-plated brass.
g. Operation: Manual
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.
j. Supply Connections: NPS 1/2.
k. Shower Head Type: Ball joint.
l. Shower Head Material: Metallic with chrome-plated finish.
m. Spray Pattern: Adjustable.

2.14 SHOWER FAUCETS

A. Shower Faucets - Standard:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. American Standard Companies, Inc.
b. Chicago Faucets.
c. Eljer.
d. Kohler Co.
e. Leonard Valve Company.

f. Moen, Inc.
g. Powers; a Watts Industries Co.
h. Symmons Industries, Inc.
i. T & S Brass and Bronze Works, Inc.
j. Zurn
k. Prior approved equal

2. Description: Single-thermostatic and pressure-balance valve. Include hot- and cold-water indicators; check stops; and shower head, arm, and flange. Coordinate faucet inlets with supplies and outlet with diverter valve.
   a. Body Material: Solid brass.
   b. Finish: Polished chrome plate.
   c. Maximum Flow Rate: 1.5 gpm, unless otherwise indicated.
   d. Diverter Valve: Not integral with mixing valve.
   e. Mounting: Wall.
   f. Operation: Manual
   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.
   i. Supply Connections: NPS 1/2.
   j. Shower Head Type: Ball joint.
   k. Shower Head Material: Metallic with chrome-plated finish.
   l. Spray Pattern: Adjustable.

B. Shower Faucets - ADA:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Standard Companies, Inc.
   b. Chicago Faucets.
   c. Eljer.
   d. Kohler Co.
   e. Leonard Valve Company.
   f. Moen, Inc.
   g. Powers; a Watts Industries Co.
   h. Symmons Industries, Inc.
   i. T & S Brass and Bronze Works, Inc.
   j. Zurn
   k. Prior approved equal
2. Description: Single-handle thermostatic and pressure-balance valve. Include hot- and cold-water indicators; check stops; and shower head, arm, and flange. Coordinate faucet inlets with supplies and outlet with diverter valve.
   a. Body Material: Solid brass.
   b. Finish: Polished chrome plate.
   c. Maximum Flow Rate: 1.5 gpm.
   d. Mounting: Exposed.
   e. Backflow Protection Device for Hand-Held Shower: Required.
   f. Operation: Manual
   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.
   i. Supply Connections: NPS 1/2.

j. Shower Head Type: Hand held, slide-bar mounted.
k. Shower Head Material: Metallic with chrome-plated finish.
l. Spray Pattern: Adjustable.

2.15 BATHTUBS

A. Bathtubs - Standard:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Kohler Co. K715.
b. Eljer.
c. American Standard Companies, Inc.
d. Prior approved equal
2. Description: Enameled, cast-iron fixture.
a. Bathing Surface: Slip resistant.
b. Size: 60 by 30.
c. Color: White.
d. Drain Location: coordinate with plumbing and architectural plans
e. Faucet: Bathtub/shower.
f. Supplies: NPS 1/2 (DN 15) copper tubing with ball, gate, or globe valves.
g. Drain Stopper: Push/Pull and twist
h. Drain Piping: NPS 1-1/2 (DN 40) cast-brass P-trap and waste.

3. Description: Porcelain-enameled, formed-steel fixture.
a. Bathing Surface: Slip resistant.
b. Size: 66"x42"
c. Color: White.
d. Drain Location: Coordinate with plumbing plans
e. Faucet: Bathtub.
f. Supplies: NPS 1/2 copper tubing with ball, gate, or globe valves.
g. Drain Stopper: Push/Pull and twist
h. Drain Piping: NPS 1-1/2 cast-brass P-trap and waste.

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 plumbing fixture installation.

B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures 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 manufacturers' written instructions.

B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.
   1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
   2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
   3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.

D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.

E. Install wall-mounting fixtures with tubular waste piping attached to supports.

F. Install floor-mounting, back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.

G. Install counter-mounting fixtures in and attached to casework.

H. Install fixtures level and plumb according to roughing-in drawings.

I. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
   1. Exception: Use ball, gate, or globe valves if supply stops are not specified with fixture. Valves are specified in Division 22 Section "Valves."

J. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

K. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

L. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

M. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.

N. Install toilet seats on water closets.

O. Install trap-seal liquid in dry urinals.

P. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

Q. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.

R. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

S. Install shower flow-control fittings with specified maximum flow rates in shower arms.

T. Install traps on fixture outlets.
   1. Exception: Omit trap on fixtures with integral traps.
   2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

U. Install disposer in outlet of each sink indicated to have disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.

V. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Basic Materials and Methods for Plumbing."

W. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 7 Section "Joint Sealants."

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

C. Ground equipment according to Electrical Section "Grounding and Bonding."

D. Connect wiring according to Electrical Section "Conductors and Cables."

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.

E. Install fresh batteries in sensor-operated mechanisms.

3.5 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Operate and adjust all fixtures. Replace damaged and malfunctioning units and controls.

C. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.

D. Replace washers and seals of leaking and dripping faucets and stops.

E. Install fresh batteries in sensor-operated mechanisms.

3.6 CLEANING

A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
   1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
   2. Remove sediment and debris from drains.

B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.7 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 15410

SECTION 15415 - DRINKING FOUNTAINS AND WATER COOLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following water coolers and related components:

1. Pressure water coolers.
2. Fixture supports.

1.3 DEFINITIONS

A. Accessible Water Cooler: Fixture that can be approached and used by people with disabilities.

B. Cast Polymer: Dense, cast-filled-polymer plastic.

C. Drinking Fountain: Fixture with nozzle for delivering stream of water for drinking.

D. Fitting: Device that controls flow of water into or out of fixture.

E. Fixture: Drinking fountain or water cooler unless one is specifically indicated.

F. Remote Water Cooler: Electrically powered equipment for generating cooled drinking water.

G. Water Cooler: Electrically powered fixture for generating and delivering cooled drinking water.

1.4 SUBMITTALS

A. Product Data: For each fixture indicated. Include rated capacities, furnished specialties, and accessories.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For fixtures to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, 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's "Directory of Certified Drinking Water Coolers" for style classifications.

E. 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.

F. ASHRAE Standard: Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant, unless otherwise indicated.

1.6 EXTRA MATERIALS

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. Filter Cartridges: Equal to 100 percent of amount installed for each type and size indicated, but no fewer than 1 of each.

PART 2 - PRODUCTS

2.1 PRESSURE WATER COOLERS

A. Water Coolers:

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

a. Elkay Manufacturing Co.
b. Acorn Aqua.
c. Haws Corporation.
d. Prior approved equal.

2. Description: Accessible, ARI 1010, Type PB, pressure with bubbler, Style W, Bi-level wall-mounting water cooler for adult and child-mounting height.

   a. Cabinet: Bilevel with two attached cabinets and with bilevel skirt kit,.
   b. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
   c. Control: Push bar.
   d. Supply: NPS 3/8 with ball, gate, or globe valve.
   e. 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.
   f. Drain(s): Grid with NPS 1-1/4 minimum horizontal waste and trap complying with ASME A112.18.1.
   g. 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.

      1) Capacity: 8 gph of 50 deg F cooled water from 80 deg F inlet water and 90 deg F ambient air temperature.
      2) Electrical Characteristics: hp; 120-V ac; single phase; 60 Hz.

   h. Support: Type II, water cooler carrier. Refer to "Fixture Supports" Article.

2.2 FIXTURE SUPPORTS

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

   1. Josam Co.
   2. MIFAB Manufacturing, Inc.
   3. Smith, Jay R. Mfg. Co.
   4. Tyler Pipe; Wade Div.
   5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
   6. Zurn Plumbing Products Group; Specification Drainage Operation.
   7. Or equal by.

B. Description: ASME A112.6.1M, water cooler carriers. Include vertical, steel uprights with feet and tie rods and bearing plates with mounting studs matching fixture to be supported.

   1. Type I: Hanger-type carrier with two vertical uprights.
   2. Type II: Bilevel, hanger-type carrier with three vertical uprights.
   3. Supports for Accessible Fixtures: Include rectangular, vertical, steel uprights instead of steel pipe uprights.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before fixture installation. Verify that sizes and locations of piping and types of supports match those indicated.

B. Examine walls and floors for suitable conditions where fixtures are to be installed.

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

3.2 APPLICATIONS

A. Use carrier off-floor supports for wall-mounting fixtures, unless otherwise indicated.

B. Use mounting frames for recessed water coolers, unless otherwise indicated.

C. Set freestanding and pedestal drinking fountains on floor.

D. Set remote water coolers on floor, unless otherwise indicated.

E. Use chrome-plated brass or copper tube, fittings, and valves in locations exposed to view. Plain copper tube, fittings, and valves may be used in concealed locations.

3.3 INSTALLATION

A. Install off-floor supports affixed to building substrate and attach wall-mounting fixtures, unless otherwise indicated.

B. Install mounting frames affixed to building construction and attach recessed water coolers to mounting frames, unless otherwise indicated.

C. Install fixtures level and plumb. For fixtures indicated for children, install at height required by authorities having jurisdiction.

D. Install water-supply piping with shutoff valve on supply to each fixture to be connected to water distribution piping. Use ball, gate, or globe valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Division 15 Section "Valves."

E. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

F. Install pipe escutcheons at wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding pipe fittings. Escutcheons are specified in Division 15 Section "Basic Mechanical Materials and Methods."

G. Seal joints between fixtures and walls and floors using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 7 Section "Joint Sealants."

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

C. Ground equipment according to Division 16 Section "Grounding and Bonding."

D. Connect wiring according to Division 16 Section "Conductors and Cables."

3.5 FIELD QUALITY CONTROL

A. Water Cooler Testing: After electrical circuitry has been energized, test for compliance with requirements. Test and adjust controls and safeties.

1. Remove and replace malfunctioning units and retest as specified above.
2. Report test results in writing.

3.6 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.

B. Adjust water cooler temperature settings.

3.7 CLEANING

A. After completing fixture installation, 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.

END OF SECTION 15415

SECTION 15441 - DOMESTIC WATER PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following all-bronze and bronze-fitted centrifugal pumps for domestic cold- and hot-water circulation:

1. Wet Rotor Circulators.

1.3 SUBMITTALS

A. Product Data: For each type and size of domestic water pump specified. Include certified performance curves with operating points plotted on curves; and rated capacities of selected models, furnished specialties, and accessories.

B. Operation and Maintenance Data: For domestic water pumps to include in operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings shall indicate size, profiles, and dimensional requirements of domestic water pumps and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.5 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 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 100% LEAD-FREE WET ROTOR CIRCULATORS

A. Manufacturers:

1. Bell & Gossett Domestic Pump; ITT Industries.
2. Armstrong Pumps Inc.
3. Grundfoss.
4. Prior approved equal.

B. Description:

1. In-line wet rotor circulation pumps designed specifically for quiet operation in open (potable) water systems. Pumps shall have 100% lead-free bronze or stainless steel bodies.
2. Provide with Aquastat.

C. Construction Materials:

1. Pump Body:

a. NBF: 100% lead-free bronze.
b. SSF: Stainless Steel.

2. Bearings: Carbon
3. Impeller:

a. NBF-33, NBF-36, NBF-45: Noryl.
b. All Others: Polypropylene.

4. Shaft: Ceramic

D. Operating Data

1. Maximum Working Pressure: 150 psi
2. Maximum Operating Temperature:

a. NBF-33, NBF-36, NBF-45: 225°F.
b. All Others: 230°F.

E. Capacities and Characteristics: Provide on drawings.

2.3 CONTROLS

A. Thermostats: Electric; adjustable for control of hot-water circulation pump.

1. Manufacturers:

a. Honeywell International, Inc.
b. Square D.
c. White-Rodgers Div.; Emerson Electric Co.
d. Prior approved equal.

2. Type: Water-immersion sensor, for installation in hot-water circulation piping.
3. Range: 65 to 200 deg F.
4. Operation of Pump: On or off.
5. Transformer: Provide if required.
6. Power Requirement: 24 V, ac or 120 V, ac.

2.4 BUILDING-AUTOMATION-SYSTEM INTERFACE

A. Provide auxiliary contacts in pump controllers for interface to building automation system. Include the following:

1. On-off status of each pump.
2. Alarm status.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of domestic-water-piping system to verify actual locations of connections before pump installation.

3.2 PUMP INSTALLATION

A. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

B. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

3.3 CONTROL INSTALLATION

A. Install immersion-type thermostats in hot-water return piping.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to pumps to allow service and maintenance.

C. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles. Refer to Division 15 Section "Domestic Water Piping."

1. Install shutoff valve and strainer on suction side of pumps, and check valve and throttling valve on discharge side of pumps. Install valves same size as connected piping. Refer to Division 15 Section "Valves" for general-duty valves for domestic water piping and Division 15 Section "Plumbing Specialties" for strainers.
2. Install pressure gages at suction and discharge of pumps. Install at integral pressure-gage tappings where provided or in suction and discharge piping. Refer to Division 15 Section "Meters and Gages" for pressure gages and gage connectors.

D. Ground equipment according to Division 16 Section "Grounding and Bonding."

E. Connect wiring according to Division 16 Section "Conductors and Cables."

F. Connect thermostats to pumps that they control.

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. Set thermostats for automatic starting and stopping operation of pumps.
5. 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.

6. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
7. Start motor.
8. Open discharge valve slowly.
9. Adjust temperature settings on thermostats.
10. Adjust timer settings.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps. Refer to Division 1 Section "Closeout Procedures and Demonstration and Training."

END OF SECTION 15441

SECTION 15469 - WATER SOFTENER

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General provisions of the Contract, including General and Supplementary Conditions and specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes commercial water softeners. Softeners shall be for the potable hot water only.
   1. Chemicals.
   2. Water testing kits.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. FRP: Fiberglass-reinforced plastic.

C. PE: Polyethylene plastic.

D. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

A. Product Data: For the following:

   1. Water Softeners. Include rated capacities, operating characteristics, furnished specialties, and accessories.
   2. Water testing kits.

B. Shop Drawings: For water softeners. Include plans, elevations, sections, details, and connections to piping systems.

   1. Wiring Diagrams: Power, signal, and control wiring.

C. Manufacturer Certificates: Signed by manufacturers certifying that water softeners comply with requirements.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For water softeners to include in operation, and maintenance manuals.

F. Warranty: Special warranty specified in this Section.

G. Maintenance service agreement.

1.5 QUALITY ASSURANCE

A. Product Options: Drawings from design/build contractor shall indicate size, profiles, and dimensional requirements of water softeners and are based on the specific system indicated. Refer to section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. ASME Compliance for Steel Tanks: Fabricate and label mineral tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, where indicated.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of water softener that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures of mineral and brine tanks.
b. Faulty operation of controls.
c. Deterioration of metals, metal finishes, and other materials beyond normal use.
d. Attrition loss of resin exceeding 3 percent per year.
e. Mineral washed out of system during service run or backwashing period.
f. Effluent turbidity greater and color darker than incoming water.
g. Fouling of underdrain system, gravel, and resin, with turbidity or by dirt, rust, or scale from softener equipment or soft water, while operating according to manufacturer's written operating instructions.

2. Commercial Water Softener, Warranty Period: From date of Substantial Completion.

a. Mineral Tanks: 10 years.
b. Brine Tanks: Five years.
c. Controls: Five years.
d. Underdrain Systems: Five years.

1.8 MAINTENANCE SERVICE

A. Maintenance: Submit four copies of manufacturer's "Agreement for Continued Service and Maintenance," before Substantial Completion, for Owner's acceptance. Offer terms and conditions for furnishing chemicals and providing continued testing and servicing to include replacing materials and equipment. Include one-year term of agreement with option for one-year renewal.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 COMMERCIAL WATER SOFTENERS

A. Description: Factory-assembled, pressure-type water softener.
   1. Manufacturers:
      a. Culligan International Company.
      b. Pacific.
      c. Columbia.
      d. Prior approved equal.
   2. Comply with NSF 61, "Drinking Water System Components--Health Effects."
   3. Configuration: Single unit with one brine tank.
   4. Mineral Tank: Steel, electric welded; pressure-vessel quality.
      a. Fabricate supports and attachments to tank with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure.
      b. Construction: Fabricated and stamped to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels."
      c. Pressure Rating: 150 psig minimum.
      d. Wetted Components: Suitable for water temperatures from 40 to at least 150 deg F.
      e. Freeboard: 50 percent minimum for backwash expansion above normal resin bed level.
      f. Handholes: 4 inches round or 4 by 6 inches elliptical, in top head and lower sidewall of tanks 30 inches and smaller in diameter.
      g. Manhole: 11 by 15 inches in top head of tanks larger than 30 inches in diameter.
      h. Support Legs or Skirt: Constructed of structural steel, welded to tank.
      i. Finish: Hot-dip galvanized on exterior and interior of tank after fabrication.
      j. Finish: Exterior of tank spray painted with rust-resistant prime coat, 2- to 3-mil dry film thickness. Interior sandblasted and lined with epoxy-polyamide coating, 8- to 10-mil dry film thickness.

k. Upper Distribution System: Single, point type, fabricated from galvanized-steel pipe and fittings.
l. Lower Distribution System: Hub and radial-arm or header-lateral type; fabricated from PVC pipe and fittings with individual, fine-slotted, nonclogging PE strainers; arranged for even flow distribution through resin bed.
m. Liner: Epoxy.

5. Controls: Fully automatic; factory mounted on unit and factory wired.
   a. Adjustable duration of various regeneration steps.
   b. Push-button start and complete manual operation.
   c. Electric time clock and switch for fully automatic operation, adjustable to initiate regeneration at any hour of day and any day of week or at fixed intervals.
   d. Sequence of Operation: Program multiport pilot-control valve to automatically pressure-actuate main operating valve through steps of regeneration and return to service.
   e. Pointer on pilot-control valve shall indicate cycle of operation.
   f. Means of manual operation of pilot-control valve if power fails.
   g. Main Operating Valves: Industrial, automatic, multiport, diaphragm type with the following features:
      1) Slow opening and closing, nonslam operation.
      2) Diaphragm guiding on full perimeter from fully open to fully closed.
      3) Isolated dissimilar metals within valve.
      4) Self-adjusting, internal, automatic brine injector that draws brine and rinses at constant rate independent of pressure.
      5) Sampling cocks for soft water.
      6) Special tools are not required for service.
   h. Flow Control: Automatic, to control backwash and flush rates over wide variations in operating pressures, and that does not require field adjustments.
      1) Meter Control: Equip each mineral tank with signal-register-head water meter that will produce electrical signal indicating need for regeneration on reaching hand-set total in gallons. Design so signal will continue until reset.
      2) Demand-Initiated Control: Equip each mineral tank of twin mineral-tank units with automatic-reset-head water meter in common outlet header that electrically activates cycle controller to automatically regenerate one mineral tank at preset total in gallons and divert flow to other tank. Set to repeat with other tank. Include electrical lockout to prevent simultaneous regeneration of both tanks.
6. Brine Tank: Combination measuring and wet-salt storing system.
   a. Tank and Cover Material: Fiberglass, 3/16 inch thick; or molded PE, 3/8 inch thick.
   b. Brine Valve: Float operated and plastic fitted for automatic control of brine withdrawn and freshwater refill.
   c. Size: Large enough for at least four regenerations at full salting.
7. Factory-Installed Accessories:
   a. Piping, valves, tubing, and drains.
   b. Sampling cocks.
   c. Main-operating-valve position indicators.

d. Water meters.

B. Capacity and Characteristics: See Drawings

2.3 CHEMICALS

A. Mineral: High-capacity, sulfonated-polystyrene ion-exchange resin that is stable over entire pH range with good resistance to bead fracture from attrition or shock.

B. Salt for Brine Tanks: High-purity sodium chloride, free of dirt and foreign material. Rock and granulated forms are not acceptable.

2.4 WATER TESTING SETS

A. Description: Manufacturer's standard water-hardness testing apparatus and chemicals with testing procedure instructions. Include metal container suitable for wall mounting.

2.5 SOURCE QUALITY CONTROL

A. Hydrostatically test mineral tanks before shipment to minimum of one and one-half times pressure rating.

B. Prepare test reports.

PART 3 - EXECUTION

3.1 CONCRETE BASES

A. Install concrete bases of dimensions indicated for commercial water softeners. Refer to Section "Basic Mechanical Materials and Methods."
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
   2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevation required for proper attachment to supported equipment.

B. Cast-in-place concrete materials and placement requirements are specified in Division 3.

3.2 WATER SOFTENER INSTALLATION

A. Install commercial water softener equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor mineral and brine tanks and floor-mounting accessories to substrate.

B. Install seismic restraints for tanks and floor-mounting accessories and anchor to building structure.

C. Install brine lines and fittings furnished by equipment manufacturer but not specified to be factory installed.

D. Prepare mineral-tank distribution system and underbed for minerals and place specified mineral into mineral tanks.

E. Install water testing sets mounted on wall, unless otherwise indicated, and near water softeners.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings shall indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Make piping connections between water-softener-unit headers and dissimilar-metal water piping with dielectric fittings. Dielectric fittings are specified in Section "Basic Mechanical Materials and Methods."

D. Install shutoff valves on raw-water inlet and soft-water outlet piping of mineral tank, and on inlet and outlet headers.
   1. Metal general-duty valves are specified in Section "Valves."
   2. Exception: Water softeners with factory-installed shutoff valves at locations indicated.

E. Install drains as indirect wastes to spill into open drains or over floor drains.

F. Ground equipment according to Section "Grounding and Bonding."

G. Connect wiring according toSection "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. 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 unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning water softeners that do not pass tests and inspections and retest as specified above.

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.

B. Add water to brine tanks and fill with salt.

C. Sample water softener effluent after startup and at three consecutive seven-day intervals (total of four samples), and prepare certified test reports for required water performance characteristics. Comply with the following:
   1. ASTM D 859, "Test Method for Silica in Water."
   2. ASTM D 1067, "Test Methods for Acidity or Alkalinity of Water."
   3. ASTM D 1068, "Test Methods for Iron in Water."
   4. ASTM D 1126, "Test Method for Hardness in Water."
   5. ASTM D 1129, "Terminology Relating to Water."
   6. ASTM D 3370, "Practices for Sampling Water from Closed Conduits."

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water softeners. Refer to Division 1 Section " Demonstration and Training."

END OF SECTION 15469

SECTION 15486 - FUEL-FIRED WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following fuel-fired water heaters:

1. Commercial, high-efficiency, gas water heaters.
2. Compression tanks.
3. Water heater accessories.

1.3 DEFINITIONS

A. LP Gas: Liquefied-petroleum fuel gas.

1.4 SUBMITTALS

A. Product Data: For each type and size of water heater indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Product Certificates: For each type of commercial water heater, signed by product manufacturer.

D. Manufacturer Seismic Qualification Certification: Submit certification that commercial water heaters, accessories, and components will withstand seismic forces defined in Division 15 Section "Mechanical Vibration and Seismic Controls." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

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.

E. Source quality-control test reports.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For water heaters to include in operation, and maintenance manuals.

H. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain same type of water heaters through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of water heaters and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

C. 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.

D. ASME Compliance:

1. Where ASME-code construction is indicated, fabricate and label commercial 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 water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.

E. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9" for all components that will be in contact with potable water.

1.6 COORDINATION

A. Coordinate size and location of concrete bases with Architectural and Structural Drawings.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired 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 Period(s): From date of Substantial Completion:

a. Household, Gas Water Heaters:

1) Storage Tank: Five years.
2) Controls and Other Components: Two years.

b. Commercial, Gas Water Heaters:

1) Storage Tank: Three years.
2) Controls and Other Components: Three years.

c. Compression Tanks: One year(s).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 COMMERCIAL, GAS WATER HEATERS

A. Commercial, High-Efficiency, Gas Water Heaters: Comply with ANSI Z21.10.3/CSA 4.3.

1. Manufacturers:

a. Lochinvar “shield” or equal by.

b. AERCO International.
c. Bradford White Corporation.
d. Laars Heating Systems; Waterpik Technologies, Inc.
e. Patterson-Kelley.
f. RBI Water Heaters; a Mestek, Inc. Company.
g. Smith, A. O. Water Products Company.
h. Prior approved equal.

2. Description: Manufacturer's proprietary design to provide at least 95 percent combustion efficiency at optimum operating conditions. Following features and attributes may be modified or omitted if water heater otherwise complies with requirements for performance.
3. Storage-Tank Construction: ASME-code steel with 150-psig minimum working-pressure rating.

   a. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.

      1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
      2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.

   b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
   c. Lining: Cement or Glass complying with NSF 61 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.

4. Factory-Installed, Storage-Tank Appurtenances:

   a. Anode Rod: Replaceable magnesium.
   b. Dip Tube: Provide unless cold-water inlet is near bottom of tank.
   c. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
   d. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
   e. Jacket: Steel with enameled finish.
   f. Combination Temperature and Pressure Relief Valves: ANSI Z21.22/CSA 4.4. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

5. Burner or Heat Exchanger: Comply with UL 795 or approved testing agency requirements for high-efficiency water heaters and for natural-gas fuel.
6. Temperature Control: Adjustable thermostat.
7. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
8. Energy Management System Interface: Normally closed dry contacts for enabling and disabling water heater.

9. Capacity and Characteristics: See Drawings

2.3 COMPRESSION TANKS

A. 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.

1. Available Manufacturers:

a. AMTROL Inc.
b. Armstrong Pumps, Inc.
c. Flexcon Industries.
d. Honeywell Sparco.
e. Myers, F. E.; Pentair Pump Group (The).
f. Smith, A. O.; Aqua-Air Div.
g. State Industries, Inc.
h. Taco, Inc.
i. Watts Regulator Co.
j. Wessels Co.
k. Prior approved equal.

2. Construction:

a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
c. Air-Charging Valve: Factory installed.

3. Capacity and Characteristics: See Drawings

2.4 WATER HEATER ACCESSORIES

A. Gas Shutoff Valves: ANSI Z21.15/CGA 9.1, manually operated. Furnish for installation in piping.

B. Gas Pressure Regulators: ANSI Z21.18, appliance type. Include pressure rating, capacity, and pressure differential required between gas supply and water heater.

C. Gas Automatic Valves: ANSI Z21.21, appliance, electrically operated, on-off automatic valve.

D. Combination Temperature and Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select each relief valve with sensing element that extends into storage tank.

1. Gas Water Heaters: ANSI Z21.22/CSA 4.4.
2. Oil-Fired Water Heaters: ASME rated and stamped and complying with ASME PTC 25.3.

E. Pressure Relief Valves: Include pressure setting less than working-pressure rating of water heater.

1. Gas Water Heaters: ANSI Z21.22/CSA 4.4.
2. Oil-Fired Water Heaters: ASME rated and stamped and complying with ASME PTC 25.3.

F. Water Heater Stand and Drain Pan Units: High-density-polyethylene-plastic, 18-inch-high, enclosed-base stand complying with IAPMO PS 103 and IAS No. 2. Include integral or separate drain pan with raised edge and NPS 1 drain outlet with ASME B1.20.1 pipe thread.

G. Water Heater Stands: Water heater manufacturer's factory-fabricated steel stand for floor mounting and capable of supporting water heater and water. Provide dimension that will support bottom of water heater a minimum of 18 inches above the floor.

H. Water Heater Mounting Brackets: Water heater manufacturer's factory-fabricated steel bracket for wall mounting and capable of supporting water heater and water.

I. Drain Pans: Corrosion-resistant metal with raised edge. Provide dimensions not less than base of water heater and include drain outlet not less than NPS 3/4.

J. Piping Manifold Kits: Water heater manufacturer's factory-fabricated inlet and outlet piping arrangement for multiple-unit installation. Include piping and valves for field assembly that is capable of isolating each water heater and of providing balanced flow through each water heater.

K. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1 or ASHRAE 90.2.

2.5 SOURCE QUALITY CONTROL

A. Test and inspect water heater storage tanks, specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test commercial water heater storage tanks before shipment to minimum of one and one-half times pressure rating.

C. Prepare test reports.

PART 3 - EXECUTION

3.1 WATER HEATER INSTALLATION

A. Install commercial water heaters on concrete bases.

1. Exception: Omit concrete bases for commercial water heaters if installation on stand, bracket, suspended platform, or direct on floor is indicated.
2. Concrete base construction requirements are specified in Division 15 Section "Basic Mechanical Materials and Methods."

B. Install 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.

C. Install seismic restraints for commercial water heaters. Anchor to substrate.

D. Install gas water heaters according to NFPA 54.

E. Install gas shutoff valves on gas supplies to gas water heaters without shutoff valves.

F. Install gas pressure regulators on gas supplies to gas water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.

G. Install automatic gas valves on gas supplies to gas water heaters, if required for operation of safety control.

H. 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.

I. Install combination temperature and pressure relief valves in water piping for water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

J. 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 water heaters that do not have tank drains. Refer to Division 15 Section "Plumbing Specialties" for hose-end drain valves.

K. Install thermometer on outlet piping of water heaters. Refer to Division 15 Section "Meters and Gages" for thermometers.

L. Install pressure gage(s) on inlet and outlet piping of commercial, fuel-fired water heater piping. Refer to Division 15 Section "Meters and Gages" for pressure gages.

M. Assemble and install inlet and outlet piping manifold kits for multiple water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each water heater. Include shutoff valve and thermometer in each water heater inlet and outlet, and throttling valve in each water heater outlet. Refer to Division 15 Section "Valves" for general-duty valves and to Division 15 Section "Meters and Gages" for thermometers.

N. Install piping-type heat traps on inlet and outlet piping of water heater storage tanks without integral or fitting-type heat traps.

O. Fill water heaters with water.

P. Charge compression tanks with air.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to water heaters to allow service and maintenance. Arrange piping for easy removal of water heaters.

C. Ground equipment according to Division 16 Section "Grounding and Bonding."

D. Connect wiring according to Division 16 Section "Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, confirm proper operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace water heaters that do not pass tests and inspections and retest as specified above.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial water heaters. Refer to Division 1 Section "Closeout Procedures Demonstration and Training."

END OF SECTION 15486

SECTION 15626 - AIR COOLED WATER CHILLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Packaged, air-cooled chillers.

1.3 DEFINITIONS

A. BAS: Building automation system.

B. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.

C. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in terms of Btu/h to the total power input given in terms of watts at any given set of rating conditions.

D. IPLV: Integrated part-load value. A single-number part-load efficiency figure of merit calculated per the method defined by ARI 550/590 and referenced to ARI standard rating conditions.

E. kW/Ton: The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in tons at any given set of rating conditions.

F. NPLV: Nonstandard part-load value. A single-number part-load efficiency figure of merit calculated per the method defined by ARI 550/590 and intended for operating conditions other than ARI standard rating conditions.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Chillers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

B. Site Altitude: Chiller shall be suitable for Cedar City altitude in which installed without affecting performance indicated. Make adjustments to affected chiller components to account for site altitude.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated. Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.

1. Performance at ARI standard conditions and at conditions indicated.
2. Performance at ARI standard unloading conditions.
3. Minimum evaporator flow rate.
4. Refrigerant capacity of chiller.
5. Oil capacity of chiller.
6. Fluid capacity of evaporator.
7. Characteristics of safety relief valves.

B. Operation and Maintenance Data: For each chiller to include in operation, and maintenance manuals.

C. Warranty: Sample of special warranty.

1.6 QUALITY ASSURANCE

A. ARI Certification: Certify chiller according to ARI 550 and ARI 590 certification programs.

B. ARI Rating: Rate chiller performance according to requirements in ARI 550/590.

C. ASME Compliance: Fabricate and label chiller to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, and include an ASME U-stamp and nameplate certifying compliance.

D. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Ship chiller from the factory fully charged with refrigerant.

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.

B. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of chillers that fail in materials or workmanship within specified warranty period.

1. Extended warranties include, but are not limited to, the following:

a. Complete chiller including refrigerant and oil charge.
b. Complete compressor and drive assembly including refrigerant and oil charge.
c. Refrigerantcharge.
d. Parts and labor.
e. Loss of refrigerant charge for any reason.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PACKAGED, AIR-COOLED CHILLERS

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

1. McQuay or equal by.
2. Trane; a division of American Standard.
3. Carrier Corporation; a United Technologies company.
4. YORK International Corporation.
5. Prior approved equal.

B. Description: Factory-assembled and run-tested chiller complete with base and frame, condenser casing, compressors, compressor motors and motor controllers, evaporator, condenser coils, condenser fans and motors, electrical power, controls, and accessories.

C. Fabricate base, frame, and attachment to chiller components strong enough to resist chiller movement during a seismic event when chiller base is anchored to field support structure.

D. Cabinet:

1. Base: Galvanized-steel base extending the perimeter of chiller. Secure frame, compressors, and evaporator to base to provide a single-piece unit.
2. Frame: Rigid galvanized-steel frame secured to base and designed to support cabinet, condenser, control panel, and other chiller components not directly supported by base.
3. Casing: Galvanized steel.
4. Finish: Coat base, frame, and casing with a corrosion-resistant coating capable of withstanding a 1000-hour salt-spray test according to ASTM B 117.

5. Sound-reduction package designed to reduce sound level without affecting performance and consisting of the following:

    a. Acoustic enclosure around compressors.
    b. Reduced-speed fans with acoustic treatment.

6. Security Package: Provide removable louvered panels with fasteners for additional protection of compressors, evaporator, and condenser coils without inhibiting service access. Finish to match cabinet.

E. Compressors:

1. Description: Positive displacement, hermetically sealed.
2. Casing: Cast iron, precision machined for minimum clearance about periphery of rotors.
3. Rotors: Manufacturer's standard one- or two-rotor design.
4. Each compressor provided with suction and discharge shutoff valves, crankcase oil heater, and suction strainer.

F. Service: Easily accessible for inspection and service.

G. Capacity Control: On-off compressor cycling and modulating slide-valve assembly or port unloaders combined with hot-gas bypass, if necessary, to achieve performance indicated.

1. Maintain stable operation throughout range of operation. Configure to achieve most energy-efficient operation possible.
2. Operating Range: From 100 to 20 percent of design capacity.
3. For units equipped with a variable frequency controller, capacity control shall be both "valveless" and "stepless," requiring no slide valve or capacity-control valve(s) to operate at reduced capacity.

H. Oil Lubrication System: Consisting of pump if required, filtration, heater, cooler, factory-wired power connection, and controls.

1. Provide lubrication to bearings, gears, and other rotating surfaces at all operating, startup, shutdown, and standby conditions including power failure.
2. Thermostatically controlled oil heater properly sized to remove refrigerant from oil.
3. Factory-installed and pressure-tested piping with isolation valves and accessories.
4. Oil compatible with refrigerant and chiller components.
5. Positive visual indication of oil level.

I. Vibration Control:

1. Vibration Balance: Balance chiller compressors and drive assemblies to provide a precision balance that is free of noticeable vibration over the entire operating range.

    a. Overspeed Test: 25 percent above design operating speed.

2. Isolation: Mount individual compressors on vibration isolators.

J. Compressor Motors:

1. Hermetically sealed and cooled by refrigerant suction gas.
2. High-torque, induction type with inherent thermal-overload protection on each phase.

K. Compressor Motor Controllers:

1. Across the Line: NEMA ICS 2, Class A, full voltage, nonreversing, or solid state.
2. Variable Frequency Controller:

   a. Motor controller shall be factory mounted and wired on the chiller to provide a single-point, field-power termination to the chiller and its auxiliaries.
   b. Description: NEMA ICS 2; listed and labeled as a complete unit and arranged to provide variable speed by adjusting output voltage and frequency.
   c. Enclosure: Unit mounted, NEMA 250, , with hinged full-front access door with lock and key.
   d. Integral Disconnecting Means: NEMA AB 1, instantaneous-trip circuit breaker with lockable handle. Minimum withstand rating shall be as required by electrical power distribution system.
   e. Technology: Pulse width modulated (PWM) output suitable for constant or variable torque loads.
   f. Motor current at start shall not exceed the rated load amperes, providing no electrical inrush.

L. Refrigerant Circuits:

1. Refrigerant: As specified by design/build contractor.
2. Refrigerant Type: R-134a R-407c. Classified as Safety Group A1 according to ASHRAE 34.
3. Refrigerant Compatibility: Chiller parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
4. Refrigerant Circuit: Each shall include a thermal- or electronic-expansion valve, refrigerant charging connections, a hot-gas muffler, compressor suction and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-corefilter-dryer, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.
5. Pressure Relief Device:

   a. Comply with requirements in ASHRAE 15 and in applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
   b. ASME-rated, spring-loaded pressure relief valve; single- or multiple-reseating type.

M. Evaporator:

1. Description: Shell-and-tube design.

a. Direct-expansion (DX) type with fluid flowing through the shell, and refrigerant flowing through the tubes within the shell.
b. Flooded type with fluid flowing through tubes and refrigerant flowing around tubes within the shell.

2. Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
3. Shell Material: Carbon steel.
4. Shell Heads: Removable carbon-steel heads located at each end of the tube bundle.
5. Fluid Nozzles: Terminated with mechanical-coupling or flanged end connections for connection to field piping.
6. Tube Construction: Individually replaceable copper tubes with enhanced fin design, expanded into tube sheets.
7. Heater: Factory-installed and -wired electric heater with integral controls designed to protect the evaporator to minus 20 deg F.
8. Remote Mounting: Designed for remote field mounting where indicated. Provide kit for field installation.

N. Air-Cooled Condenser:

1. Plate-fin coil with integral subcooling on each circuit, rated at 450 psig.

a. Construct coil casing of galvanized steel.
b. Construct coils of copper tubes mechanically bonded to aluminum fins.
c. Coat coils with a baked-epoxy, corrosion-resistant coating after fabrication.
d. Hail Protection: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.

2. Fans: Direct-drive propeller type with statically and dynamically balanced fan blades, arranged for vertical air discharge.
3. Fan Motors: Totally enclosed nonventilating (TENV) or totally enclosed air over (TEAO) enclosure, with permanently lubricated bearings. Equip each motor with overload protection integral to either the motor or chiller controls.
4. Fan Guards: Steel safety guards with corrosion-resistant coating.

O. Electrical Power:

1. Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point, field-power connection to chiller.
2. House in a unit-mounted, NEMA 250, enclosure with hinged access door with lock and key.
3. Wiring shall be numbered and color-coded to match wiring diagram.
4. Install factory wiring outside of an enclosure in a raceway.
5. Provide each motor with overcurrent protection.
6. Overload relay sized according to UL 1995 or an integral component of chiller control microprocessor.
7. Phase-Failure and Undervoltage Relays: Solid-state sensing with adjustable settings.
8. Provide power factor correction capacitors.

9. Control Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.

    a. Power unit-mounted controls where indicated.
    b. Power unit-mounted, ground fault interrupt (GFI) duplex receptacle.

10. Control Relays: Auxiliary and adjustable time-delay relays.
11. For chiller electrical power supply, indicate the following:

    a. Current and phase to phase for all three phases.
    b. Voltage, phase to phase, and phase to neutral for all three phases.
    c. Three-phase real power (kilowatts).
    d. Three-phase reactive power (kilovolt amperes reactive).
    e. Power factor.
    f. Running log of total power versus time (kilowatt-hours).
    g. Fault log, with time and date of each.

P. Controls:

1. Standalone and microprocessor based.
2. Enclosure: Share enclosure with electrical power devices.
3. Operator Interface: Multiple-character digital or graphic display with dynamic update of information and with keypad or touch-sensitive display located on front of control enclosure. In either imperial or metric units, display the following information:

    a. Date and time.
    b. Operating or alarm status.
    c. Operating hours.
    d. Outdoor-air temperature if required for chilled-water reset.
    e. Temperature and pressure of operating set points.
    f. Entering and leaving temperatures of chilled water.
    g. Refrigerant pressures in evaporator and condenser.
    h. Saturation temperature in evaporator and condenser.
    i. No cooling load condition.
    j. Elapsed time meter (compressor run status).
    k. Pump status.
    l. Antirecycling timer status.
    m. Percent of maximum motor amperage.
    n. Current-limit set point.
    o. Number of compressor starts.

4. Control Functions:

    a. Manual or automatic startup and shutdown time schedule.
    b. Entering and leaving chilled-water temperatures, control set points, and motor load limits. Chilled-water leaving temperature shall be reset based on return-water temperature.
    c. Current limit and demand limit.
    d. External chiller emergency stop.

e. Antirecycling timer.
f. Variable evaporator flow.

5. Manually Reset Safety Controls: The following conditions shall shut down chiller and require manual reset:

   a. Low evaporator pressure or high condenser pressure.
   b. Low chilled-water temperature.
   c. Refrigerant high pressure.
   d. High or low oil pressure.
   e. High oil temperature.
   f. Loss of chilled-water flow.
   g. Control device failure.

6. Trending: Capability to trend analog data of up to five parameters simultaneously over an adjustable period and frequency of polling.
7. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: view only; view and operate; and view, operate, and service.
8. Control Authority: At least four conditions: Off, local manual control at chiller, local automatic control at chiller, and automatic control through a remote source.
9. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display chiller status and alarms.

   a. Hardwired Points:

      1) Monitoring: On-off status, common trouble alarm electrical power demand (kilowatts) electrical power consumption (kilowatt-hours).
      2) Control: On-off operation, chilled-water, discharge temperature set-point adjustment electrical power demand limit.

   b. University Accepted communication interface with the BAS shall enable the BAS operator to remotely control and monitor the chiller from an operator workstation. Control features and monitoring points displayed locally at chiller control panel shall be available through the BAS.

Q. Insulation:

1. Material: Closed-cell, flexible elastomeric, thermal insulation complying with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
2. Thickness: 1-1/2 inches.
3. Factory-applied insulation over cold surfaces of chiller components.

   a. Adhesive: As recommended by insulation manufacturer and applied to 100 percent of insulation contact surface. Seal seams and joints.

4. Apply protective coating to exposed surfaces of insulation to protect insulation from weather.

R. Accessories:

1. Factory-furnished, chilled-water flow switches for field installation.
2. Individual compressor suction and discharge pressure gages with shutoff valves for each refrigerant circuit.
3. Factory-furnished neoprene isolators for field installation.
4. Tool Kit: Chiller manufacturer shall assemble a tool kit specially designed for use in serving the chiller(s) furnished. Include special tools required to service chiller components not readily available to Owner service personnel in performing routine maintenance. Place tools in a lockable case with hinged cover. Provide a list of each tool furnished and attach the list to underside of case cover.

S. Capacities and Characteristics: Provided by design/build contractor.

2.2 SOURCE QUALITY CONTROL

A. Perform functional tests of chiller before shipping.

B. Factory run test air-cooled chiller with water flowing through evaporator.

C. Factory performance test air-cooled chillers, before shipping, according to ARI 550/590.

1. Test the following conditions:

a. Design conditions indicated.

2. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.

D. Factory sound test air-cooled chillers, before shipping, according to ARI 370.

1. Test the following conditions:

a. Design conditions indicated.

2. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.

E. Factory test and inspect evaporator and condenser according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

F. For chillers located outdoors, rate sound power level according to ARI 370.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine chiller before installation. Reject chiller that are damaged.

B. Examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, and electrical connections to verify actual locations, sizes, and other conditions affecting chiller performance, maintenance, and operations before equipment installation.

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

3.2 CHILLER INSTALLATION

A. Install chiller on support structure.

B. Equipment Mounting: Install chiller on concrete base using elastomeric pads. Comply with requirements for concrete bases specified in Division 3 Section "Cast-in-Place Concrete." Comply with requirements for vibration isolation devices specified in Division 15 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

1. Minimum Deflection: 1/2 inch.
2. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
3. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Maintain manufacturer's recommended clearances for service and maintenance.

D. Install separate devices furnished by manufacturer and not factory installed.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in Division 15 Section "Hydronic Piping" and Division 15 Section "Refrigerant Piping". Drawings shall indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to chiller to allow service and maintenance.

C. Evaporator Fluid Connections: Connect to evaporator inlet with shutoff valve, flexible connector, thermometer, and plugged tee with pressure gage. Connect to evaporator outlet with shutoff valve, balancing valve, flexible connector, flow switch, thermometer, plugged tee with shutoff valve and pressure gage, and drain connection with valve. Make connections to chiller with a flange or mechanical coupling.

D. Connect each chiller drain connection with a union and drain pipe. Provide a shutoff valve at each connection.

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.
2. Verify that refrigerant charge is sufficient and chiller has been leak tested.
3. Verify that pumps are installed and functional.
4. Verify that thermometers and gages are installed.
5. Operate chiller for run-in period.
6. Check bearing lubrication and oil levels.
7. Verify proper motor rotation.
8. Verify static deflection of vibration isolators, including deflection during chiller startup and shutdown.
9. Verify and record performance of fluid flow and low-temperature interlocks for evaporator.
10. Verify and record performance of chiller protection devices.
11. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assembly, installation, and connection.

C. Prepare test and inspection startup reports.

3.5 DEMONSTRATION

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

END OF SECTION 15626

SECTION 15710 - HYDRONIC AND STEAM HEAT EXCHANGERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes shell-and-tube heat exchanger.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Operation and Maintenance Data: For heat exchanger to include in operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, performance, and dimensional requirements of heat exchanger and are based on the specific equipment indicated. Refer to Division 1 Section "Product Requirements."

B. ASME Compliance: Fabricate and label heat exchanger to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.

C. Registration: Fabricate and label shell-and-tube heat exchangers to comply with the Tubular Exchanger Manufacturers Association's standards.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SHELL-AND-TUBE HEAT EXCHANGERS

A. Manufacturers:

1. API Heat Transfer Inc.
2. Armstrong Pumps, Inc.
3. ITT Industries; Bell & Gossett.
4. Taco, Inc.
5. Thrush Company, Inc.
6. Prior approved equal.

B. Configuration: U-tube with removable bundle.

C. Shell Materials: Steel.

D. Head:

1. Materials: Cast iron.
2. Flanged and bolted to shell.

E. Tube:

1. Seamless copper tubes.
2. Tube diameter is determined by manufacturer based on service.

F. Tubesheet Materials: Steel tubesheets.

G. Baffles: Steel.

H. Piping Connections:

1. Shell: 300 # steam flanged inlet and outlet fluid connections, threaded drain, and vent connections.
2. Head: 150 #Flanged hot water inlet and outlet connections.

I. Support Saddles:

1. Fabricated of material similar to shell.
2. Foot mount with provision for anchoring to support.
3. Fabricate attachment of saddle supports to pressure vessel with reinforcement strong enough to resist heat-exchanger movement during a seismic event when heat-exchanger saddles are anchored to building structure.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas for compliance with requirements for installation tolerances and for structural rigidity, strength, anchors, and other conditions affecting performance of heat exchangers.

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

3.2 HEAT-EXCHANGER INSTALLATION

A. Install shell-and-tube heat exchangers on saddle supports.

B. Install shell-and-tube heat exchangers on concrete base. Concrete base is specified in Division 15 Section "Basic Mechanical Materials and Methods," and concrete materials and installation requirements are specified in Division 3.

C. Concrete Bases: Anchor heat exchanger to concrete base.

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Cast-in-place concrete materials and placement requirements are specified in Division 3.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections.

B. Maintain manufacturer's recommended clearances for service and maintenance. Install piping connections to allow service and maintenance of heat exchanger.

C. Install shutoff valves at heat-exchanger inlet and outlet connections.

D. Install relief valves on heat-exchanger heated-fluid connection and install pipe relief valves, full size of valve connection, to floor drain.

E. Install vacuum breaker at heat-exchanger steam inlet connection.

F. Install hose end valve to drain shell.

3.4 FIELD QUALITY CONTROL

A. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 CLEANING

A. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain heat exchangers. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION 15710

SECTION 15725 – CENTRAL STATION AIR HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Requirements of the following Division 15 Sections apply to this section:

1. 15010 - “General Requirements”.
2. 15051 - “Basic Materials and Methods General Requirements”.

1.2 SUMMARY

A. This Section includes constant-volume and variable-volume, factory custom-built, air-handling units with coils, for indoor installations.

B. Related Sections: The following Sections contain requirements that relate to this section:

1. Section 15074 “Vibration, Noise Controls, & Seismic Protection” for inertia bases, isolation pads, and vibration isolation hangers and supports.
2. Section 15055 “Motors”
3. Section 15900, DDC "Control Systems" for control devices.
4. Division 16 Electrical: Including but not limited to disconnects, circuit breakers, motor controllers and motor control centers, and variable frequency drives.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Section 15051 and Division 1 Specification Sections.

1. Product data for each air-handling unit indicated, including the following:

a. Certified fan performance curves with system operating conditions indicated.
b. Certified fan sound power ratings.
c. Certified coil performance ratings at

1) system operating conditions indicated.
2) half airflow and half water flow conditions.

d. Motor ratings and electrical characteristics plus motor and fan accessories.
e. Materials gages and finishes.
f. Filters with performance characteristics.
g. Dampers, including housings, linkages, and operators.

2. Shop drawings from manufacturer detailing dimensions, required clearances, components, and location and size of each field connection.
3. Coordination drawings for air-handling units in accordance with Section 15051.
4. Wiring diagrams detailing wiring for power and controls and differentiating between manufacturer-installed wiring and field-installed wiring.
5. Product certificates signed by manufacturers of air-handling units certifying that their products comply with specified requirements.
6. Field quality control test reports specified in Part 3 of this Section.
7. Maintenance data for air-handling units for inclusion in Operating and Maintenance Manual.

1.4 QUALITY ASSURANCE

A. NFPA Compliance: Air-handling units and components shall be designed, fabricated, and installed in compliance with NFPA Standard 90A "Standard for the Installation of Air Conditioning and Ventilating Systems."

B. ARI Certification: Air-handling units and their components shall be factory tested in accordance with the applicable portions of ARI 430 - Standard for Central-Station Air-Handling Units and shall be listed and bear the label of the Air Conditioning and Refrigeration Institute.

C. Manufacturers Qualifications: Firms regularly engaged in the manufacture of factory custom built air handling units of similar construction, size and duty as required by these contract plans and specifications for a period of not less than 10 years prior to the bid date of this project.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Lift and support units with the manufacturer's designated lifting or supporting points.

B. Disassemble and reassemble units as required for movement into the final location following manufacturer's written instructions.

C. Deliver air-handling units as a factory-assembled unit to the extent allowable by shipping limitations, with protective crating and covering.

1.6 SEQUENCING AND SCHEDULING

A. Coordinate the size and location of concrete equipment pads. Cast anchor bolt inserts into pad.

B. Coordinate the size and location of structural steel support members.

1.7 EXTRA MATERIALS

A. Furnish one additional complete set of filters for each air-handling unit.

B. Furnish one additional complete set of belts for each air-handling unit.

C. Provide one drive change if required to meet installed conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Temtrol.
2. Haakon
3. McQuay
4. York

2.2 MANUFACTURED UNITS

A. General Description: Factory assembled, consisting of fans, motor and drive assembly, coils, damper, plenums, filters, drip pans, and mixing dampers. Equipment must be fabricated and assembled in the USA.

B. All Air-handling units shall be a Blow-through configuration.

2.3 CASING

A. All walls shall be constructed of minimum (2) inch thick "double wall" acoustical thermal panels. The inner wall shall be a minimum of 22 gage, perforated galvanized steel. All units are required to maintain wall stiffness of 1/200th of an/inch at 1.5 times the working pressure. The insulation shall be 2 inch, 3.0 lb./cu ft. density fiberglass. All permanently joined flanged panel surfaces shall be sealed with an individual strip of tape sealer and caulked with a high grade silicone sealant. Wall (and roof) seams shall be turned inward to provide a clean flush exterior finish. All panel seams shall be sealed during assembly to produce an airtight unit. All wall and ceiling panels shall be designed with reinforcement for a negative 6” wg static pressure on all panels on suction side of the fans and a positive 6” wg pressure on the discharge side of the fans.

1. Frame & Panel Construction:

a) Walls and roof of each unit shall have a support framework constructed of welded tubular steel to which all exterior and interior panels are mechanically fastened.
b) Exterior wall panels shall be a minimum of 16 gage galvanized steel.

2. Standing Seam Panel Construction:

   a) The manufacturer shall make the exterior casing panels out of a minimum 14 gage galvanized steel, with the panel width not to exceed 24"each.
   b) The panels shall be constructed of heavier gauge steel, shorter panel widths, or angle iron stiffeners may be added as required to maintain casing deflection criteria of 1/200 at 1.5 times the working pressure. If panels cannot meet this deflection criteria, add additional internal reinforcing.

B. All insulation edges shall be protected from exposure to the air stream by the use of metal lagging if required to accomplish such.

C. Encapsulate fiberglass insulation with mylar.

D. AHU's shall ship as one single piece whenever feasible. If multiple sections are required, the units shall be engineered for simple demount and field assembly. Mounting frames of each section shall be fabricated with a flanged perimeter which is drilled with assembly clearance bolting holes and is continuously gasketed. Demount gaskets supplied with the unit shall be a high quality weather resistant closed cell neoprene sponge rubber. Assembly lugs, fabricated from structural steel with appropriate assembly clearance holes shall be welded to the base frame and color coded for ease of assembly. All gasket and necessary assembly hardware shall ship with the unit sections, boxed separately and clearly marked.

E. The AHU framework and casing construction shall be fabricated in such a manner as to comply with the following requirements:

   1. Provide an airtight unit that will not leak greater than 1% of the specified airflow at the rated static pressures.
   2. Access doors shall be provided of sufficient size to allow for removal of any components for replacement or repair such as fan wheels, shafts, motors, or coils, without structural degradation of the unit.

F. AHU’s shall be rated and pass a maximum 1% air leakage rate test. The AHU manufacturer shall conduct a cabinet air leakage test prior to shipping unit. Test results shall be submitted to the engineer prior to installation. Results shall be included in the O & M manuals.

   1. The cabinet shall be tested at the unit design operating static pressures. Cabinet leakage is not to exceed SMACNA leak class 9 (or 1% of the specified air flow) on the operating air side of the unit.
   2. Leak testing shall be performed by measuring the air flow into (or out of) the air handling unit at the designed operating static pressures. A chambered nozzle with a variable supply system, as described in AMCA STANDARD 210-85, must be used as the airflow measurement system.
   3. All supply and return air openings are to be sealed along with the air seal at the

supply fan to isolate the high and low side of the unit.

4. The airflow measurement system shall be ducted to the unit. The airflow pumped into (or out of) the unit is to be measured at the appropriate operating pressures.
5. The pressure drop across the chambered nozzle shall be measured with a manometer. The airflow will then be calculated using the AMCA STANDARD 210 equation 9.3.2.8 FLOW RATE FOR CHAMBER NOZZLES.

2.4 BASE CONSTRUCTION

A. Units shall be constructed from a minimum 2 X 5 X 10 gage tubular steel fitted with cross members to support all interior components. Frame to be continuously welded at all joints. Units less than or equal to 20 ft. long shall have a minimum 5 inch base, and units greater than 20 ft. shall have a minimum of 6 inch base.

B. A 12 gage tread plate or anti-slip surface floor shall be installed on the base. Floor shall be level, reinforced from below, with all seams continuously welded around the perimeter of floor. Floor shall be guaranteed not to leak with 2" inches of standing water. Base shall be provided with lifting lugs, minimum four (4) per unit section. The base shall be insulated with minimum 3 inch fiberglass insulation and sheeted with a 20 gage galvanized exterior steel liner.

C. Provide a 1.5 inch high perimeter collar around each floor opening.

D. Provide auxiliary drains in fan sections downstream of cooling coils and in mixing sections. Drain pans shall be 3" deep fabricated of 16 gage, 304 stainless steel with 1-1/4" MPT connections mounted below the bottom of the drain pan and the 20 gage subfloor of the unit. Drain pan shall be sloped to the outlet in the pan floor so as to prevent any standing water to accumulate in the drain pan. Stacked coils shall have intermediate drain pans with copper downspouts to the main drain pan. Units without such intermediate drain pans for stacked coils will not be accepted.

E. All drain connections on floor mounted air handling units shall terminate at the nearest floor drain.

2.5 ACCESS DOORS

A. Access doors shall be manufactured from 16 gage galvanized steel. The doors shall be double wall construction with 20 gage solid metal liner on the inside. Corners of the doors shall be continuously welded for rigidity. Two inch 3.0 lb./cu ft. density insulation shall be sandwiched between the 16 gage outer layer and the 20 gage inner layer. Door frames are to have thermal break allowing no through metal contact.

B. Two metal latches operable from either side of door shall be provided. Door opening shall be fully gasketed with continuous neoprene/EDPM rubber bulb type gasket rated for a constant exposure temperature range of -20°F to 160°F. All doors shall swing open against the AHU component section pressure unless leakage rate specified can be achieved otherwise. Doors shall have door tie backs to secure an open position.

Door frames shall be made from 16 gage galvanized steel with the outside of the door flush with the unit. Minimum door opening size shall be 24 in. x 60 in. (where unit height permits).

2.6 FANS

A. Fan bearings shall be heavy duty, pillow block, self-aligning ball type (roller bearings for all 33" diameter and greater fans). Bearings shall be selected for a minimum L-50 life (200,000) hours at maximum horsepower and operating speed for classification. Both bearings shall have the same bore, type and manufacturer. Rigid supports for both must be removable for access to the wheel. Inlet cone shall be precision spun. Provide inlet screen made of minimum 1/8 inch diameter steel rods arranged into a circular grid pattern with interwoven radial spokes. Fan shaft shall be turned, ground and polished solid steel rated at maximum RPM below critical speed. Fan wheel and sheaves shall be keyed to the shaft. Fan shall be IRD balanced at design RPM to a vibration velocity less than or equal to .080 inches per second measured at each bearing pad prior to shipment with motor, sheaves and belts in place. Fan shall be rated in accordance with AMCA 300 for sound.

B. Variable volume fans speed shall be controlled by variable frequency drives (VFD) as furnished and installed by Division 16.

C. Provide a metal belt guard having sides of galvanized steel and expanded metal face with openings for fan tachometer readings. Belt guard shall be sized to allow either sheave to be increased by two sizes. Interlocking door "kill" switch, factory mounted, can be furnished in lieu of a belt guard or fan screen. Field wiring of kill switch to any remote mounted starting equipment shall be done by the mechanical contractor.

D. An I-beam shall be factory installed at the roof, inside the AHU casing, above the motor for any motor 15 HP or greater. This I-beam shall serve as a permanent device from which the motor can be lifted from its mounting position by cable or chain and then easily moved to the access door for removal from the AHU.

2.7 VIBRATION ISOLATION

A. An integral all welded steel vibration isolation base shall be provided for the fan and motor.

B. Seismic certified spring isolators shall be free standing with sound deadening pads and leveling bolts.

C. Spring diameter to compressed operating height ratio shall be 1 to 1.

D. Spring deflection shall be 2 inch.

E. Isolators shall have integral seismic restraints. If isolators are not a seismic rated assembly, then the restraint device must be approved and stamped by a licensed engineer duly registered in the state of the project site.

2.8 MOTORS

A. Include the following:

1. Bases: Adjustable.
2. Bearings: The following features are required:

   a. Ball or roller bearings with inner and outer shaft seals.
   b. Grease lubricated.
   c. Designed to resist thrust loading where belt drives or other drives produce lateral or axial thrust in motor.

3. Enclosure Type: The following features are required:

   a. Open drip-proof motors where satisfactorily housed or remotely located during operation.
   b. Guarded drip-proof motors where exposed to contact by employees or building occupants.

4. Overload protection: Built-in, automatic reset, thermal overload protection.
5. Noise rating: Quiet.
6. Nameplate: Indicate the full identification of manufacturer, ratings, characteristics, construction, and special features.

B. Starters, Electrical Devices, and Wiring: Electrical devices and connections to comply with Division 16.

2.9 COILS

A. Coils shall be fully enclosed within casing and mounted on primed with Zinc rich chromate primer and painted angle iron or stainless steel racks manufactured to allow coils to slide out individually.

B. Removable coil access panels shall be provided to remove coils through casing wall. Coils shall be individually removable towards (away from) the access side.

C. Drain pans shall be 16 gage, 304 stainless steel. Intermediate drain pans shall be interconnected with 1 inch copper drain lines.

D. Coils shall be designed for direct expansion refrigerant service with a minimum 5/8" diameter tubing. Maximum fpi shall be 11.

E. Coils shall be certified in accordance with ARI Standard 410.
F. Coils shall be hydrostatically tested at 400 Psig, and shall be suitable for working pressures and temperatures up to 200 Psig and 220 degrees F. Coil tube thickness shall be 0.035 inch minimum thickness. Fin thickness shall be 0.008 inch minimum.

Coils must have brazed U-bend return bends. Hairpin construction type coils will not be accepted.

G. Pipe connections shall be on the same end, and shall be threaded.

H. Coils indicated as being cleanable shall have either a cleanout plug for each tube or shall have a gasketed removable header cover.

I. Coil face velocity shall not exceed 600 FPM.

J. Coils with turbulators will not be accepted.

2.10 FILTERS

A. Filters shall be installed in a prefabricated channel rack.

B. Filters shall be lift-out where access is available upstream of the filter, or side out when access is not available.

2.11 FILTER GAGES

A. Provide Dwyer 2000 magnehelic gages factory installed on casing of AHU.

B. Magnehelic gages shall be accurate to +2% of full range.

C. Sensing probes and shut off valves shall be provided for each gage.

D. One gage shall be provided for each filter bank.

2.12 FINISH

A. Unit shall be finished painted with two component etch bond primer and finish painted with alkyd enamel, color as selected by Architect. All uncoated steel shall be painted with red oxide primer. All metal surfaces shall be painted with vinyl wash primer to ensure paint bond to metal. Bright spangled galvanized finish is acceptable in lieu of painted finish.

2.13 LIGHTS

A. Marine lights with protective metal cage, glass seals and bulbs, complete with duplex receptacles shall be installed on the wall across from the access doors. A switch with an indicator light shall be installed on the unit. Electrical power shall be 120/1/60.

2.14 DAMPERS

A. Dampers and frames shall be made from 14 gage galvanized steel or extruded aluminum. Dampers shall be airfoil style. Maximum blade length shall be 48 inches.

Maximum blade width shall be 6 inches.

B. Drive shafts shall be made with ½" inch min. square stainless steel mounted in nylon bearings for a positive no-slip control through clamps. Round shafts with set screws to secure linkage or hex shafts are not acceptable. The damper linkage shall be outside of the air stream. Linkage shall be located at each side of damper blades with positive non-slip clamping at each damper shaft.

C. Blade seals shall be PVC suitable for -40 degrees F. air temperatures.

D. Jamb seals shall be stainless steel.

E. Jack shaft assemblies shall be provided for multiple damper installations.

F. Position damper parallel blades so that return air and outside air streams are directed toward each other to promote better mixing of the air.

G. Damper actuators to be supplied by the ATC contractor. Specified torque requirements for each damper assembly shall be coordinated with the ATC contractor to ensure a sufficient quantity and size of actuators is used to provide a complete shut-off of the dampers.

2.15 ELECTRICAL SERVICE

A. The unit shall have factory installed conduit and wiring to a single point in the field exterior to the AHU casing, for the power wiring circuit, and the 120 Volt Service Circuit.

B. All wiring and components shall comply with the current National Electrical Code and Division 16.

C. Provide a 120/1/60 service outlet inside unit.

D. Wire the Anti-Microbial Growth suppression System in series with the service outlet.

E. Unit shall be ETL listed and labeled.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances, housekeeping pads, and other conditions affecting performance of air-handling units.
B. Examine rough-in for electrical service and steam, hydronic, and condensate drain piping to verify actual locations of connections prior to installation.

C. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Install air-handling units level and plumb, in accordance with manufacturer's written instructions. Maintain manufacturer's recommended clearances.

1. Support floor-mounted units on concrete equipment bases. Secure units to anchor bolts installed in concrete equipment base.

B. Arrange installation of units to provide access space around air-handling units for service and maintenance.

3.3 EQUIPMENT BASES

A. Construct concrete equipment pads as follows:

1. Coordinate size of equipment bases with actual unit sizes provided. Construct base 4 inches larger in both directions than the overall dimensions of the supported unit.
2. Form concrete pads with framing lumber with form release compounds. Chamfer top edge and corners of pad.
3. Install reinforcing bars, tied to frame, and place anchor bolts and sleeves to facilitate securing units. Provide #4 rebar at 12" O.C. both ways.
4. Place concrete and allow to cure before installation of units. Use Portland Cement conforming to ASTM C 150, 4,000 psi compressive strength, and normal weight aggregate.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 sections. The Drawings indicate the general arrangement of piping, valves, fittings, and specialties. The following are specific connection requirements:

1. Arrange piping installations adjacent to units to allow unit servicing and maintenance.
2. Connection piping to air-handling units with flexible connectors.
3. Connect condensate drain pans using Type L copper tubing. Extend to the nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

B. Duct installations and connections are specified in other Division 15 sections. Make final duct connections with flexible connections.

C. Electrical Connections: The following requirements apply:

1. Electrical power wiring is specified in Division 16.

2. Temperature control wiring and interlock wiring is specified in Division 15 Section "Control Systems."
3. Grounding: Connect unit components to ground in accordance with the National Electrical Code.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Inspection: Arrange and pay for a factory-authorized service representative to perform the following:

1. Inspect the field assembly of components and installation of air-handling units including piping, ductwork, and electrical connections.
2. Prepare a written report on findings and make recommended corrective actions.

3.6 ADJUSTING, CLEANING, AND PROTECTING

A. Adjust water coil flow, with control valves to full coil flow, to indicated gpm.

B. Adjust damper linkages for proper damper operation.

C. Clean unit cabinet interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheel, fan cabinet, and coils entering air face.

3.7 START UP

A. Final Checks Before Start-Up: Perform the following operations and checks before start-up:

1. Remove shipping, blocking, and bracing.
2. Verify unit is secure on mountings and supporting devices and that connections for piping, ductwork, and electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects.
3. Perform cleaning and adjusting specified in this Section.
4. Disconnect fan drive from motor and verify proper motor rotation direction and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.
5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
6. Set zone dampers to full open for each zone.
7. Set outside-air and return-air mixing dampers to minimum outside-air setting.
8. Comb coil fins for parallel orientation.
9. Install clean filters.
10. Verify manual and automatic volume control, and fire and smoke dampers in connected ductwork systems are in the full-open position.
11. Disable automatic temperature control operators.

B. Starting procedures for air-handling units:

1. Energize motor, verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM.

    a) Replace fan and motor pulleys as required to achieve design conditions.

2. Measure and record motor electrical values for voltage and amperage.

C. Shut unit down and reconnect automatic temperature control operators.

D. Refer to Division 15 Section "Testing, Adjusting, and Balancing" for procedures for air-handling-system testing, adjusting, and balancing.

3.8 DEMONSTRATION

A. Demonstration Services: Arrange and pay for a factory-authorized service representative to train Owner's maintenance personnel on the following:

1. Procedures and schedules related to start-up and shut down, troubleshooting, servicing, preventative maintenance, and how to obtain replacement parts.
2. Familiarization with contents of Operating and Maintenance Manuals.

B. Schedule training with at least 7 days' advance notice.

END OF SECTION 15725

SECTION 15763 - FAN-COIL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes fan-coil units and accessories.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, configuration operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Operation and Maintenance Data: For fan-coil units to include in operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:

1. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.

E. Warranty: Special warranty specified in this Section.

1.4 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.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of condensing units that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Compressor failure.
b. Condenser coil leak.

2. Warranty Period: Five years from date of Substantial Completion.
3. Warranty Period (Compressor Only): Five years from date of Substantial Completion.
4. Warranty Period (Condenser Coil Only): Five years from date of Substantial Completion.

1.6 EXTRA MATERIALS

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. Fan-Coil-Unit Filters: Furnish one spare filter for each filter installed.
2. Fan Belts: Furnish one spare fan belt for each unit installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

B. In the Fan-Coil-Unit Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FAN-COIL UNITS

A. Manufacturers:

1. Carrier Corporation.
2. McQuay International.
3. IEC
4. Trane.

5. Johnson Controls/York.
6. Prior approved equal.

B. Description: Factory-packaged and -tested units rated according to ARI 440, ASHRAE 33, and UL 1995. Vertical configuration, floor mounted including cabinet, filter, chassis, coil, drain pan, fan and motor in blow through configuration with hydronic cooling and heating coils.

C. Fan coils shall be provided with ECM motor, and direct drive configuration.

D. Coil Section Insulation: 1-inch thick, coated glass fiber complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.

1. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.

E. Main and Auxiliary Drain Pans: Insulated galvanized steel formed to slope from all directions to the drain connection as required by ASHRAE 62..

F. Chassis: Galvanized steel with flanged edges. Floor-mounting units shall have leveling screws.

G. Cabinet: Steel with baked-enamel finish in manufacturer's standard paint color as selected by Architect.

1. Vertical Unit Front Panels: Removable, steel, with steel discharge grille and channel-formed edges, cam fasteners, and insulation on back of panel.

H. Outdoor-Air Damper: Galvanized-steel blades with edge and end seals and nylon bearings; with electronic, actuators.

I. Filters: Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

1. MERV 13 Minimum

J. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, 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.

K. Fan and Motor Board: Removable.

1. Fan: Forward curved, double width, centrifugal; directly connected to motor. Painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
2. Motor: Permanently lubricated, ECM; resiliently mounted on motor board. Comply with requirements in Division 15 Section "Motors."
3. Wiring Termination: Connect motor to chassis wiring with plug connection.

L. Control devices and operational sequences are specified in Division 15 Sections "HVAC Instrumentation and Controls" and "Sequence of Operation."

M. Basic Unit Controls:

1. Control voltage transformer.
2. Wall-mounting thermostat with the following features:

   a. Heat-cool-off switch.
   b. Fan on-auto switch.
   c. Fan-speed switch.
   d. Automatic changeover.
   e. Adjustable deadband.
   f. Exposed set point.
   g. Exposed indication.
   h. Degree F indication.

3. Outdoor-Air Damper Operation:

   a. Occupied Periods:
      1) Outdoor-Air Temperature above Room Temperature: Position damper to fixed minimum position for design outdoor air.

   b. Unoccupied Periods: Close damper.

N. BAS Interface Requirements:

1. Interface relay for scheduled operation.
2. Monitor space temperature.

O. Electrical Connection: Factory wire motors and controls for a single electrical connection.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive fan-coil units for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping and electrical connections to verify actual locations before fan-coil-unit installation.

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

3.2 INSTALLATION

A. Install fan-coil units level and plumb.

B. Install fan-coil units to comply with NFPA 90A.

C. Vibration isolators for floor mounts are specified in Division 15 Section "Mechanical Vibration and Seismic Controls."

D. Coordinate locations of thermostats and any other exposed control sensors with room details before installation. Install devices 48 inches above finished floor.

E. Install new filters in each fan-coil unit within two weeks after Substantial Completion.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings by the design/build teams shall indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:

1. Install piping adjacent to machine to allow service and maintenance.
2. Connect condensate drain to indirect waste.

a. Install condensate trap of adequate depth to seal against the pressure of fan. Install cleanouts in piping at changes of direction.

B. Ground equipment according to Division 16 Section "Grounding and Bonding."

C. Connect wiring according to Division 16 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust equipment installation, including connections. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.5 ADJUSTING

A. Adjust initial temperature set points.

B. 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.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fan-coil units. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION 15763

SECTION 15815 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round and flat-oval ducts and fittings.
3. Sheet metal materials.
4. Duct liner.
5. Sealants and gaskets.
6. Hangers and supports.
7. Seismic-restraint devices.

B. Related Sections:

1. Division 15 Section "Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.
2. Division 15 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing requirements for metal ducts.
3. Division 15 Section “Diffusers, Registers and Grilles.”

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated.

1. Static-Pressure Classes:

a. Supply Ducts: 2-inch wg.
b. Return Ducts (Negative Pressure): 1-inch wg.
c. Exhaust Ducts (Negative Pressure): 1-inch wg.

2. Leakage Class:

a. Round Supply-Air Duct: 3 cfm/100 sq. ft. at 1-inch wg.
b. Flat-Oval Supply-Air Duct: 3 cfm/100 sq. ft. at 1-inch wg.

c. Rectangular Supply-Air Duct: 6 cfm/100 sq. ft. at 1-inch wg.
d. Flexible Supply-Air Duct: 6 cfm/100 sq. ft. at 1-inch wg.

B. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."

1. Seismic Hazard Level A: Seismic force to weight ratio, 0.48.
2. Seismic Hazard Level B: Seismic force to weight ratio, 0.30.
3. Seismic Hazard Level C: Seismic force to weight ratio, 0.15.

1.4 SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.
3. Seismic-restraint devices.
4. Fire-stopping material

B. Field quality-control reports.

1.5 QUALITY ASSURANCE

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

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.

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 1-4, "Transverse (Girth) 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 1-5, "Longitudinal Seams - Rectangular Ducts," 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 2, "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 AND FLAT-OVAL 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.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

a. Lindab Inc.
b. McGill AirFlow LLC.
c. SEMCO Incorporated.
d. Sheet Metal Connectors, Inc.
e. Spiral Manufacturing Co., Inc.
f. Metco.
g. Prior approved equal.

B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter (diameter of the round sides connecting the flat portions of the duct).

C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," 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. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," 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."

E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "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: G60.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

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.

2.4 CLOTHES DRYER EXHAUST DUCTWORK

A. Ductwork and dampers shall be aluminum. Interior surfaces shall be smooth. There shall be no obstruction inside the duct, such as metal screws or screens; Joints shall be sealed with a “Tape Sealing System” as specified in this section.

B. Ducts exhausting at the roof shall terminate with an elbow for horizontal discharge. Provide a flapper-type backdraft damper at the terminus.

C. Ducts exhausting through the wall shall terminate with a weather cap and a flapper-type backdraft damper.

D. Ducts shall be installed in accordance with the dryer manufacturer’s instructions and in compliance with the International Mechanical Code.

2.5 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

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

a. CertainTeed Corporation; Insulation Group.
b. Johns Manville.
c. Knauf Insulation.
d. Owens Corning.
e. Prior approved equal.
f. Maximum Thermal Conductivity:

1) Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
2) Type II, Rigid: 0.23 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. Solvent-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.

B. Insulation Pins and Washers:

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

C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-19, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct.
6. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
7. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:

   a. Fan discharges.

2.6 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:

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.

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.

2.7 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

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.

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.

2.8 SEISMIC-RESTRAINT DEVICES

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

1. Cooper B-Line, Inc.; a division of Cooper Industries.
2. Ductmate Industries, Inc.
3. Hilti Corp.
4. Kinetics Noise Control.
5. Mason Industries.
6. Unistrut Corporation; Tyco International, Ltd.
7. Prior approved equal.

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.

D. Restraint Cables: ASTM A 603, galvanized-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.

E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.

F. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. The design/build drawings shall include, schematics, and diagrams indicating general location and arrangement of duct system. Indicate duct locations, configurations, and arrangements.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round and flat-oval 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 over or 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 Division 15 Section "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 "Duct Cleanliness for New Construction Guidelines."

3.2 SEAM AND JOINT SEALING

A. Seal duct seams and joints for duct static-pressure and leakage classes specified in "Performance Requirements" Article, according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 1-2, "Standard Duct Sealing Requirements," unless otherwise indicated.

1. For static-pressure classes 1- and 1/2-inch wg, comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Seal Class C, except as follows:

a. Ducts that are located directly in zones they serve.

3.3 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "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.

3.4 SEISMIC-RESTRAINT-DEVICE INSTALLATION

A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."

1. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
2. Brace a change of direction longer than 12 feet.

B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install cable restraints on ducts that are suspended with vibration isolators.

E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction.

F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.

G. Drilling for and Setting Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Division 15 Section "Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual."
2. Test the following systems:

   a. Supply air.
   b. Return air.
   c. Exhaust air.

3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.

C. 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.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.7 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 Division 15 Section "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, condensate drain pans, 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.

3.8 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as follows:

1. Clothes dryer vents.

a. Exposed to View: Aluminum.
b. Concealed: Aluminum.

2. Moist Environment Ducts: Aluminum.

B. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.
2. Aluminum Ducts: Aluminum or galvanized sheet steel coated with zinc chromate. Dryers only.

C. Liner:

1. Supply- and Return-Air Ducts: Fibrous glass, Type I.

D. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."

a. Velocity 1000 fpm or Lower:

1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
2) Mitered Type RE 4 without vanes.

b. Velocity 1000 to 1500 fpm:

1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."

2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."

a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.

b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

E. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."

a. Rectangular Main to Rectangular Branch: 45-degree entry.
b. Rectangular Main to Round Branch: Spin in.

2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees." Saddle taps are permitted in existing duct.

a. Velocity 1000 fpm or Lower: 90-degree tap.
b. Velocity 1000 to 1500 fpm: Conical tap.

F. Duct Schedule

1. Rectangular duct with liner:

a. Low pressure supply and return.

2. Rectangular duct wrapped with insulation:

a. Low pressure exhaust and fresh air.

3. Single wall round with wrapped insulation.

a. Low pressure supply and return.

END OF SECTION 15815

SECTION 15820 - DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Backdraft dampers.
2. Volume dampers.
3. High Efficiency Take-Offs.
4. Motorized control dampers.
5. Fire dampers.
6. Ceiling fire dampers.
7. Duct Silencers.
8. Combination fire and smoke dampers.
9. Turning vanes.
10. Duct-mounting access doors.
11. Flexible connectors.
12. Flexible ducts.
13. Duct accessory hardware.

B. Related Sections include the following:

1. Division 15 Section "HVAC Instrumentation and Controls" for electric damper actuators.

1.3 SUBMITTALS

A. Product Data: For the following:

1. Backdraft dampers.
2. Volume dampers.
3. High Efficiency Take-Offs.
4. Motorized control dampers.
5. Fire dampers.
6. Ceiling fire dampers.
7. Duct Silencers.
8. Combination fire and smoke dampers.
9. Turning vanes.
10. Duct-mounting access doors.
11. Flexible connectors.

12. Flexible ducts.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

1.5 EXTRA MATERIALS

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. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SHEET METAL MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated.

B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G60 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.

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. Manufacturers:

1. Air Balance, Inc.
2. American Warming and Ventilating.
3. Duro Dyne Corp.
4. Greenheck.
5. Penn Ventilation Company, Inc.
6. Prefco Products, Inc.
7. Ruskin Company.
8. Air Rite.
9. Prior approved equal.

B. Description: Multiple-blade, parallel action gravity balanced, with blades of maximum 6-inch width, with sealed edges, assembled in rattle-free manner with 90-degree stop, steel ball bearings, and axles; adjustment device to permit setting for varying differential static pressure.

C. Frame: 0.052-inch- thick, galvanized sheet steel, with welded corners and mounting flange.

D. Blades: 0.025-inch- thick, roll-formed aluminum.

E. Blade Seals: Neoprene.

F. Blade Axles: Galvanized steel.

G. Tie Bars and Brackets: Galvanized steel.

H. Return Spring: Adjustable tension.

2.4 VOLUME DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. American Warming and Ventilating.
3. METALAIRE, Inc.
4. Nailor Industries Inc.
5. Penn Ventilation Company, Inc.
6. Ruskin Company.
7. Air Rite.
8. Prior approved equal.

B. General Description: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.

C. Standard Volume Dampers: Opposed-blade design, standard leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.

1. Steel Frames: Hat-shaped, galvanized sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
2. Roll-Formed Steel Blades: 0.064-inch- thick, galvanized sheet steel.
3. Blade Axles: Galvanized steel.
4. Bearings: Oil-impregnated bronze.
5. Tie Bars and Brackets: Galvanized steel.

D. Damper Hardware: 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. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

2.5 HIGH EFFICIENCY TAKE-OFF

A. Factory-manufactured rectangular-to-round or round-to-round 45 degree leading tap fabricated of 24 ga zinc-coated lockforming quality steel sheets meeting requirements of ASTM A 653, with G-90 coating.

B. One inch wide mounting flange with die formed corner clips, pre-punched mounting holes, and adhesive coated gasket.

C. Manual Volume Damper:

1. Single blade, 22 ga minimum.
2. 3/8 inch minimum square rod with brass damper bearings at each end.
3. Heavy duty locking quadrant on 1-1/2 inch high stand-off mounting bracket attached to side of round duct.

D. Approved Manufacturers:

1. HETD-L by Daniel Manufacturing.
2. STO by Flexmaster USA Inc.
3. HET by Sheet Metal Connectors Inc.
4. Hercules.
5. Air-Rite.
6. Prior approved equal.

2.6 MOTORIZED CONTROL DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. American Warming and Ventilating.
3. Duro Dyne Corp.
4. Greenheck.
5. McGill AirFlow Corporation.
6. METALAIRE, Inc.
7. Nailor Industries Inc.

8. Penn Ventilation Company, Inc.
9. Ruskin Company.
10. Vent Products Company, Inc.
11. Air Rite.
12. Prior approved equal.

B. General Description: AMCA-rated, opposed-blade design; minimum of 0.1084-inch-thick, galvanized-steel frames with holes for duct mounting; minimum of 0.0635-inch-thick, galvanized-steel damper blades with maximum blade width of 8 inches.

1. Secure blades to 1/2-inch- diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
2. Operating Temperature Range: From minus 40 to plus 200 deg F.
3. Provide closed-cell neoprene edging.

2.7 FIRE DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. Greenheck.
3. McGill AirFlow Corporation.
4. METALAIRE, Inc.
5. Nailor Industries Inc.
6. Penn Ventilation Company, Inc.
7. Prefco Products, Inc.
8. Ruskin Company.
9. Vent Products Company, Inc.
10. Prior approved equal.

B. Fire dampers shall be labeled according to UL 555.

C. Fire Rating: 1-1/2 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: 0.052 or 0.138 inch thick as indicated and of length to suit application.
2. Exceptions: Omit sleeve where damper frame width permits direct attachment of perimeter mounting angles on each side of wall or floor, and thickness of damper frame complies 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. Fusible Links: Replaceable, 165 deg F rated.

2.8 CEILING FIRE DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. Greenheck.
3. McGill AirFlow Corporation.
4. METALAIRE, Inc.
5. Nailor Industries Inc.
6. Penn Ventilation Company, Inc.
7. Prefco Products, Inc.
8. Ruskin Company.
9. Vent Products Company, Inc.
10. Prior approved equal.

B. General Description: Labeled according to UL 555C; comply with construction details for tested floor- and roof-ceiling assemblies as indicated in UL's "Fire Resistance Directory."

C. Frame: Galvanized sheet steel, round or rectangular, style to suit ceiling construction.

D. Blades: Galvanized sheet steel with refractory insulation.

E. Fusible Links: Replaceable, 165 deg F rated.

2.9 SMOKE AND COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. Greenheck.
3. Nailor Industries Inc.
4. Penn Ventilation Company, Inc.
5. Ruskin Company.
6. Prior approved equal.

B. General Description: Labeled according to UL 555S. Combination fire and smoke dampers shall be labeled according to UL 555 for 1-1/2-hour rating.

C. Fusible Links: Replaceable, 165 deg F rated.

D. Frame and Blades: 0.064-inch- thick, galvanized sheet steel.

E. Mounting Sleeve: Factory-installed, 0.052-inch- thick, galvanized sheet steel; length to suit wall or floor application.

F. Damper Motors: Modulating and two-position action.

1. Comply with requirements in Division 15 Section "Motors."
2. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
3. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
4. Outdoor Motors and Motors in Outside-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
5. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
6. Electrical Connection: 115 V, single phase, 60 Hz.

2.10 TURNING VANES

A. Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.

B. Manufactured Turning Vanes: Fabricate 1-1/2-inch- wide, single-vane, curved blades of galvanized sheet steel set 3/4 inch o.c.; support with bars perpendicular to blades set 2 inches o.c.; and set into vane runners suitable for duct mounting.

1. Available Manufacturers:

a. Ductmate Industries, Inc.
b. Duro Dyne Corp.
c. METALAIRE, Inc.
d. Prior approved equal.

C. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

2.11 DUCT-MOUNTING ACCESS DOORS

A. General Description: Fabricate doors airtight and suitable for duct pressure class.

B. Door: Double wall, duct mounting, and rectangular; fabricated of galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class. Include vision panel where indicated. Include 1-by-1-inch butt or piano hinge and cam latches.

1. Manufacturers:

a. American Warming and Ventilating.
b. Ductmate Industries, Inc.
c. Flexmaster U.S.A., Inc.
d. Greenheck.
e. McGill AirFlow Corporation.
f. Nailor Industries Inc.
g. Ventfabrics, Inc.
h. Ward Industries, Inc.
i. Air Rite.
j. Prior approved equal.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Provide number of hinges and locks as follows:

a. Less Than 12 Inches Square: Secure with two sash locks.
b. Up to 18 Inches Square: Two hinges and two sash locks.
c. Up to 24 by 48 Inches: Three hinges and two compression latches.
d. Sizes 24 by 48 Inches and Larger: One additional hinge.

C. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.

D. Insulation: 1-inch- thick, fibrous-glass or polystyrene-foam board.

2.12 FLEXIBLE CONNECTORS

A. Manufacturers:

1. Ductmate Industries, Inc.
2. Duro Dyne Corp.
3. Ventfabrics, Inc.
4. Prior approved equal.

B. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying 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. Select metal compatible with 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.

E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz./sq. yd..
2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.

3. Service Temperature: Minus 50 to plus 250 deg F.

2.13 FLEXIBLE DUCTS

A. Manufacturers:

1. Flexmaster U.S.A., Inc.
2. Hart & Cooley, Inc.
3. McGill AirFlow Corporation.
4. Themaflex.
5. Prior approved equal.

B. Insulated-Duct Connectors: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene or aluminized 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 20 to plus 210 deg F.

C. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 through 18 inches to suit duct size.

2.14 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 APPLICATION AND INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts.

B. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel.

C. Install backdraft dampers on exhaust fans or exhaust ducts nearest to outside.

D. Install volume dampers in ducts with liner; avoid damage to and erosion of duct liner.

E. Provide balancing dampers at points on supply, return, and exhaust systems where branches lead from larger ducts as required for air balancing. Install at a minimum of two duct widths from branch takeoff.

F. Provide test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire and smoke dampers, with fusible links, according to manufacturer's UL-approved written instructions.

H. Install duct access doors to allow for inspecting, adjusting, and maintaining accessories and terminal units as follows:

1. On both sides of duct coils.
2. Adjacent to fire or smoke dampers, providing access to reset or reinstall fusible links.
3. To interior of ducts for cleaning; before and after each change in direction, at maximum 50-foot spacing.
4. On sides of ducts where adequate clearance is available.

I. Install the following sizes for duct-mounting, rectangular access doors:

1. One-Hand or Inspection Access: 8 by 5 inches.
2. Two-Hand Access: 12 by 6 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.

J. Install the following sizes for duct-mounting, round access doors:

1. One-Hand or Inspection Access: 8 inches in diameter.
2. Two-Hand Access: 10 inches in diameter.
3. Head and Hand Access: 12 inches in diameter.
4. Head and Shoulders Access: 18 inches in diameter.
5. Body Access: 24 inches in diameter.

K. Label access doors according to Division 15 Section "Mechanical Identification."

L. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.

M. Connect diffusers to low pressure ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.

N. Connect flexible ducts to metal ducts with draw bands.

O. Install duct test holes as required for testing and balancing purposes.

3.2 ADJUSTING

A. Adjust duct accessories for proper settings.

B. Adjust fire and smoke dampers for proper action.

C. Final positioning of manual-volume dampers is specified in Division 15 Section "Testing, Adjusting, and Balancing."

END OF SECTION 15820

SECTION 15838 - EXHAUST FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Centrifugal roof ventilators.
2. Inline exhaust 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 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and 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. Dampers, including housings, linkages, and operators.
5. Roof curbs.

B. Field quality-control test reports.

C. Operation and Maintenance Data: For power ventilators 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, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

D. UL Standard: Power ventilators shall comply with UL 705.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

1.7 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 CENTRIFUGAL ROOF VENTILATORS

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

1. Loren Cook Company ACE-B or equal by
2. Acme Engineering & Mfg. Corp.
3. Breidert Air Products.
4. Carnes Company HVAC.
5. Greenheck.
6. JencoFan; Div. of Breidert Air Products.
7. Penn Ventilation.
8. Prior approved equal.

B. Description: Belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

C. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.

1. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.

D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

E. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:

1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
4. Fan and motor isolated from exhaust airstream.

F. Accessories:

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
3. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.

G. 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 cant and mounting flange.
2. Overall Height: 12 inches.
3. Sound Curb: Curb with sound-absorbing insulation matrix.
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.

H. Capacities and Characteristics: Provide schedule on design/build drawings.

2.2 INLINE EXHAUST FANS

A. In line belt drive exhaust fan

1. Furnish and install belt drive inline centrifugal fan, having inlet and discharge diameter not less than shown on fan schedule
2. Fan housing, fan wheel and other parts used in fabrication of the unit shall be aluminum
3. Each belt drive unit will have the motor externally mounted with adjustable motor base and motor sheave through:

a. Lubricating tubes shall be provided for the shaft bearings.
b. All units will have support brackets standard with the manufacturer for mounting the unit

4. Fan wheel shall be aluminum having aluminum true airfoil blades heliarc welded to the hub with non-overloading characteristics.

    a. Straightening vanes shall be heliarc welded at the discharge side if the units to eliminate turbulence.

5. Approved Manufacturers

    a. Cook SQN or equal by
    b. Acme Engineering & Mfg. Corp.
    c. Breidert Air Products
    d. Carnes Company HVAC.
    e. JencoFan; Div of Breidert Air Products.
    f. Penn Ventilation.
    g. Prior approved equal.

2.3 MOTORS

A. Comply with requirements in Division 15 Section "Motors."

B. Enclosure Type: Totally enclosed, fan cooled.

2.4 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Support units using restrained spring isolators having a static deflection of 1 inch. Vibration- and seismic-control devices are specified in Division 15 Section "Mechanical Vibration and Seismic Controls."

C. Install units with clearances for service and maintenance.

D. Label units according to requirements specified in Division 15 Section "Mechanical Identification."

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 15 Sections. Drawings shall indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 15 Section "Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Division 16 Section "Grounding and Bonding."

D. Connect wiring according to Division 16 Section "Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

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. Verify lubrication for bearings and other moving parts.
7. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
8. Shut unit down and reconnect automatic temperature-control operators.
9. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

A. Adjust belt tension.

B. Refer to Division 15 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing procedures.

C. Replace fan and motor pulleys as required to achieve design airflow.

D. Lubricate bearings.

END OF SECTION 15838

SECTION 15840 - VARIABLE AIR VOLUME BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Shutoff single-duct VAV boxes (air terminal units).

1.3 SUBMITTALS

A. Product Data: For each type of product indicated, include rated capacities, furnished specialties, sound-power ratings, and accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.

1. Include a schedule showing unique model designation, room location, model number, size, and accessories furnished.
2. Wiring Diagrams: Power, signal, and control wiring.

C. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Closeout Procedures Operation and Maintenance Data," include the following:

1. Instructions for resetting minimum and maximum air volumes.
2. Instructions for adjusting software set points.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of air terminal units and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. NFPA Compliance: Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

1.5 COORDINATION

A. Coordinate layout and installation of air terminal units and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SHUTOFF SINGLE-DUCT AIR TERMINAL UNITS

A. Available Manufacturers:

1. Price Industries model SDV or equal by.
2. Carnes.
3. Carrier
4. Krueger.
5. Nailor Industries of Texas Inc.
6. Titus.
7. Trane Co. (The); Worldwide Applied Systems Group.
8. Tuttle & Bailey.
9. Prior Approved Equal.

B. Configuration: Volume-damper assembly inside unit casing with control components located inside a protective metal shroud.

C. Casing: 0.034-inch steel.

1. Casing Lining: 1-inch- thick, coated, fibrous-glass duct liner complying with ASTM C 1071; secured with adhesive.
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 dampers and other parts requiring service, adjustment, or maintenance; with airtight gasket.

D. Regulator Assembly: Extruded-aluminum or galvanized-steel components; key damper blades onto shaft with nylon-fitted pivot points located inside unit casing.

1. Automatic Flow-Control Assembly: Combined spring rates shall be matched for each volume-regulator size with machined dashpot for stable operation.
2. Factory-calibrated and field-adjustable assembly with shaft extension for connection to externally mounted control actuator.

E. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: ARI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.
2. Damper Position: Normally open.

F. Hot-Water Heating Coil: Copper tube, mechanically expanded into aluminum-plate fins; leak tested underwater to 200 psig; and factory installed.

G. DDC Controls: Bidirectional damper operators and microprocessor-based controller and room sensor shall be compatible with temperature controls specified in Division 15 Section "HVAC Instrumentation and Controls" and shall have the following features:

1. Damper Actuator: 24 V, powered closed, spring return open.
2. Terminal Unit Controller: Pressure-independent, variable-air-volume 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. Proportional, plus integral control of room temperature.
b. Time-proportional reheat-coil control.
c. Occupied and unoccupied operating mode.
d. Remote reset of airflow or temperature set points.
e. Adjusting and monitoring with portable terminal.
f. Communication with temperature-control system specified in Division 15 Section "HVAC Instrumentation and Controls."

3. Room Sensor: Wall mounting, with temperature set-point adjustment and access for connection of portable operator terminal.

H. Control Sequence:

1. Suitable for operation with duct pressures between 0.25- and 3.0-inch wg inlet static pressure.
2. Factory-mounted and -piped, 5-micron filter; velocity-resetting, adjustable, high-limit control; and amplifying relay.
3. System-powered, wall-mounting thermostat.

2.3 SOURCE QUALITY CONTROL

A. Identification: Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.

B. Verification of Performance: Rate air terminal units according to ARI 880.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to air terminal units to allow service and maintenance.

C. Hot-Water Piping: In addition to requirements in Division 15 Section "Hydronic Piping," 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.

D. Connect ducts to air terminal units according to Division 15 Section "Metal Ducts."

E. Connect wiring according to Division 16 Section "Conductors and Cables."

F. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

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. Remove and replace malfunctioning units and retest as specified above.

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 and do the following:

a. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
b. Verify that controls and control enclosure are accessible.
c. Verify that control connections are complete.
d. Verify that nameplate and identification tag are visible.
e. Verify that controls respond to inputs as specified.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air terminal units. Refer to Division 1 Section "Closeout Procedures Demonstration and Training."

END OF SECTION 15840

SECTION 15855 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes ceiling diffusers and wall-mounted registers, and grilles.

B. Related Sections include the following:

1. Division 15 Section "Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 SUBMITTALS

A. Product Data: For each product indicated, include the following:

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, Register, and Grille Schedule: Provide schedule on design/build drawings indicating, model number, size, and accessories furnished.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Products: Subject to compliance with requirements, provide one of the products specified.

2.2 GRILLES AND REGISTERS

A. Adjustable Bar Side Wall Supply Grille:

1. Products:

a. Carnes; RVEA.

b. Krueger; 5815.
c. METALAIRE, Inc., Metal Industries Inc.; 422.
d. Price Industries; LBMR.
e. Titus; 1707.
f. Tuttle & Bailey; VF5.
g. Or prior approved equal:

2. Material: Aluminum.
3. Finish: Baked enamel, white.
4. Face Blade Arrangement: Adjustable horizontal spaced 1/4 inch apart.
5. Frame: 1 inch wide.

B. Fixed Face Ceiling Return, Exhaust, or Transfer Air Grille:

1. Products:

a. Carnes; RSLA.
b. Krueger; S85H.
c. Price Industries; 535.
d. Titus; 355RL.
e. Tuttle & Bailey; T70D.
f. Or prior approved equal:

2. Material: Steel.
3. Finish: Baked enamel, white.
4. Face Arrangement: 1/2 inch horizontal blade spacing.
5. Frame: 1-1/4 inches wide.

C. Low Sidewall Return Grilles

1. Material: Steel.
2. Finish – Standard white baked enamel.
3. Zero degree deflection.
4. Approved Manufacturers And Models

a. Carnes - RSHA
b. J & J - S-590
c. Krueger - S480H
d. Metalaire - HD-RH
e. Price - 90-L
f. Titus - 30RL or 30 SL
g. Tuttle & Bailey - T110 or equal by
h. Prior approved equal.

2.3 LINEAR SLOT OUTLETS

A. Linear Slot Diffuser:

1. Manufacturers:

a. Anemostat; a Mestek Company.
b. Carnes.
c. Krueger.
d. METALAIRE, Inc.; Metal Industries Inc.
e. Nailor Industries of Texas Inc.
f. Price Industries.
g. Titus.
h. Tuttle & Bailey.
i. Prior approved equal.

2. Material - Shell: Steel, insulated.
3. Material - Pattern Controller and Tees: Aluminum.
4. Finish - Face and Shell: Baked enamel.
5. Finish - Pattern Controller: Baked enamel.
6. Finish - Tees: Baked enamel, white.
7. Slot Width: Indicate on design/build drawings.
8. Number of Slots: Indicate on design/build drawings.

2.4 CEILING DIFFUSER OUTLETS

A. Rectangular and Square Ceiling Diffusers:

1. Products:

a. Carnes; SK-A.
b. Krueger; SH.
c. METALAIRE, Inc., Metal Industries Inc.; 55005.
d. Price Industries; SMD.
e. Titus; TDC.
f. Tuttle & Bailey; MS.
g. Or prior approved equal:

1) A-J Manufacturing Co., Inc.
2) Anemostat; a Mestek Company.
3) Hart & Cooley, Inc.; Hart & Cooley Div.
4) Nailor Industries of Texas Inc.

2. Material: Steel.
3. Finish: Baked enamel, white.

2.5 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles 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, registers, and grilles are to be 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, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Design/build drawings shall indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations shall be located to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. For units installed in lay-in ceiling panels, provide lay-in ceiling module. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, 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, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 15855

SECTION 15900 – AUTOMATIC TEMPERATURE CONTROLS

PART – 1 GENERAL

1.1 RELATED DOCUMENTS:

A. The General Conditions, Supplementary General Conditions, alternates and addenda, and the technical specifications, shall apply to all work under this division.

B. The Contractor shall carefully review all notes, coordination schedules, and drawings for work required under this section of the specification.

C. Division – 15 General Mechanical Requirement's sections apply to work of this section.

D. Commissioning of HVAC Systems.

1. This contractor shall include preparation of all trends, as well as communication and verification as required by the commissioning agent.

1.2 SCOPE OF WORK:

A. It is intended for the building automation system to be fully networked and installed by a qualified Automatic Temperature Control Contractor. The control system shall consist of electronic type direct digital controllers, input/output module panels, transmission equipment, training, warranty service and accessory equipment for a completely installed system of automatic temperature control.

B. Control sequences are specified in "Sequence of Operation."

C. The ATC Contractor shall furnish and install a complete system of DDC automatic temperature control as specified based on the Snow College Metasys head end.

D. The temperature control contractor shall install all necessary electrical control wiring of all temperature controls, heating and ventilating equipment motor starting circuit controls and all electrical control interlocks for same, and for any equipment furnished by the Owner.

E. The Automatic Temperature Control Contractor shall supply and supervise any and or all installation of control valves, water flow switches, temperature well and automatic dampers. Installation of such shall be by Div. 15 Mechanical Contractor.

F. The temperature control contractor shall allow a minimum of eight (8) hours for system adjustments and fine-tuning of control systems.

1.3 NOT INCLUDED IN SCOPE OF WORK:

A. The electrical contractor shall furnish and install all single phase and multiphase electrical power wiring to magnetic starters, disconnect switches, VFD's, motors and smoke detectors.

B. Electrical contractor shall be responsible for 120V service to DDC equipment control panels.

C. The supply and installation of control dampers shall be by Div. 15 Sheet Metal Contractor. Damper actuators are to be as specified and are the responsibility of the controls contractor for proper sizing and installation.

PART – 2 EXECUTION

2.1 QUALITY ASSURANCE:

A. Acceptable Control Contractors and Control Manufacturers shall be as follows:

1 Johnson Metasys.
2 Prior approved equal

B. Any deviation from this specification shall be brought to the attention of the Mechanical Engineer. It is the responsibility of the contractor to provide an installation that meets the requirements of the specification. Submitting an explanation for deviation from the specification does not any way guarantee that the engineer shall approve the deviation. Due diligence should be followed at all times.

C. Provide unconditional ONE-YEAR parts warranty as part of the overall project warranty.

D. All parts and material used, as well as how they are installed shall be in accordance with the specification as given by the manufacturer. All parts and material shall be new.

E. The Contractor or firm awarded the project work of this section shall have 15 years experience in work of similar scope and nature to that specified. Subcontracting of any part or parts of the project is not admissible, including but not limited to installation and commissioning.

F. The ATC Contractor shall be a branch office of a control manufacturer or an authorized factory representative of a control manufacturer.

G. The ATC Contractor shall have a minimum of ten years operating DDC systems in the geographical area covered by his local organization or branch office.

H. The ATC Contractor shall have in-house and factory qualified Engineering, Programming, Installation, Start-up and Service capability.

2.2 CODES:

A. Comply with NEMA standards pertaining to components and devices for electric control systems.

B. Provide electrical products that have been tested listed and labeled by UL and comply with NEMA standards.

C. Comply with NEMA 90A Standard for the Installation of Air Conditioning and Ventilation Systems where applicable to control sequences and controls.

D. Comply with NEMA 70, all current National Electric Codes, and all state and local laws, and ordinances for all electrical installation.

E. Power wiring (120 VAC or higher) to fans and to all other heating and ventilating equipment including the control panels shall be furnished by the Electrical Contractor. This Contractor is responsible for all control wiring (24 VAC or DC or lower) that is specified in connection with the Automatic Temperature Control System found in this section or elsewhere in other sections or drawings. Any such work or wiring specified in the electrical drawings or other sections as being performed by Div. 16000 electrical contractor shall be excluded from the ATC Contractors scope of work.

F. Temperature control wiring shall be installed in conduit only. State-licensed electricians and apprentices in a planned training program in compliance with state and local regulations and guidelines shall perform all conduit, wiring, and control equipment installations. .

G. Wiring in equipment/mechanical rooms shall be in conduit.

2.3 SUBMITTAL AND TECHNICAL INFORMATION

A. Prior to any and or all installation, the Contractor shall submit a complete control system submittal, shop Drawings (7 sets) and manufacturer's data with details of the Automatic Temperature Control and Direct Digital Control Systems. The following items to be accredited to both the facility management operator (maintenance) and the engineer.

B. Complete system control diagrams including electrical and system flow diagrams.

C. Control sequence and material list of each component(s) and its individual description.

D. Complete and detailed sequence of operation including specific reference to points list, flow diagrams, and control valve schematics and sequence.

E. Manufactures specification sheets for each control component selected.

F. Documentation of all software and hardware. These manuals shall be complete with installation procedures as well as start up and programming instructions. They should also contain any testing or maintenance procedures required for operating the system on continuous basis.

G. Complete training schedule to include date(s), time and instructors itinerary.

H. Maintenance manuals shall provide descriptions of maintenance on all system components, including sensors and controlled devices. They shall cover inspection, periodic preventative maintenance, fault diagnosis, and repair or replacement of defective components.

I. Other hardware or parts as required.

2.4 OWNER INSTRUCTION UPON COMPLETION OF PROJECT:

A. Upon completion of the project, the temperature control contractor's representative shall spend minimum eight (8) hours with the building's operating personnel to instruct them on the operation of the system. See General Provisions, Scope of Work.

B. Upon completion of this project, the temperature control contractor shall provide to the owner’s building operating personnel (Two Persons chosen by the owner) Factory Instruction and Training from Tridium Inc. in a certified course conducted by Tridium Inc in the use and operation of a JACE Router/Network Controller and the associated software. This training shall be provided with any travel, food and lodging associated with facilitating this course necessary for the selected owner personnel to attend. It shall be a standard course not to exceed 40 hours.

C. A letter of completion and acceptance of the Owner shall be delivered to the Owner and Consulting Engineering Firm.

2.5 ELECTRICAL WIRING:

A. All power wiring (120 VAC or higher) to fans and to all other heating and ventilating equipment including the control panels shall be furnished by the Electrical Contractor. This Contractor is responsible for all control wiring (24 VAC or DC or lower) not shown on electrical drawings or specified elsewhere in connection with the Automatic Temperature Control System (ATC). All temperature control wiring shall be installed in conduit. All conduit, wiring, and control equipment installation shall be performed by state licensed electricians employed directly by the ATC contractor

2.6 GUARANTEE:

A. Components, parts, and assemblies shall be guaranteed against defects in materials and workmanship for a period of two years after acceptance. Expressed warranties are conditionally

based on the requirement that the items covered within the guarantee are used and maintained in accordance with the manufacturer's recommendations.

B. The guarantee commences at the time of project acceptance and continues for the previously indicated duration.

PART – 3 PRODUCTS

3.1 GENERAL

A. The Control System shall be a user programmable, electronic, direct-digital control system. The system shall be designed and manufactured for the purpose of building heating and air conditioning control. The system shall meet all requirements of these specifications. Any deviation from this specification shall be brought to the attention to the Mechanical Engineer in writing including justification for the deviation. If the engineer rejects the deviation from the specification, then the specified controls and/or equipment shall be required. No resubmission will be excepted.

B. Direct Digital Control System - Overview: The direct digital control system shall consist of a local microprocessor-based Java Application Control Engine type Router/Network Controller that will provide Graphic User Interfacing Screens available from a Operator Workstation Computer. The computer shall meet the necessary requirements in order to perform its functions and allow access to the LAN and Internet that the Building Automation System is connected to. The Router/Network Controller shall be connected to a Local Area Ethernet-based Network that is provided exclusively by the owner or other providers. The Router/Network Controller shall be networked, though an industry standard BACNET, to individual Stand-alone BACNET DDC Controllers associated with each piece of equipment specified. It is the intent of these specifications to create a combined direct digital control system. All "system" type control functions, such as those used for fan systems, convertors, chillers, central plant and pumps, building pressurization etc., shall be accomplished by using software algorithms in the respective DDC units. All safety devices such as fire alarm shutdown, smoke detectors, low limit thermostats, etc., shall be hard wired to accomplish their critical functions completely independent of the DDC units and shall have additional outputs as required to serve as inputs to the DDC units for secondary control and reporting functions.

C. Stand-alone Controllers (DDC units): Each controller shall be a microprocessor and shall form the basic control unit of the system. They shall be completely BACNET compliant. It shall operate as a stand-alone unit providing all the necessary algorithms and software logic to perform the local HVAC control sequences and energy saving functions. Failure of any one DDC units shall have no affect on the other DDC units in the system. Programming shall be accomplished by an optional operator's engineering terminal or via the services of a technician from the Automatic Temperature Control Contractor as optionally contracted. The controller shall consis t of a microprocessor and Input/ Output Modules (I/O) as required by the control application. It shall include a full range of control functions including proportional (P), proportional plus integral (PI), ON/OFF with adjustable switching differential, floating with adjustable dead band, time proportional with adjustable cycle time and maximum time. The controller shall operate

independent of any central computer, shall have built-in diagnostic routines, shall allow for custom software programs and allow complete control and logic functions interlock.

D. The DDC units shall utilize EEPROM, allowing changes to programming and data base to be stored in the DDC units, updating all previous programming and erasing all previous data that is no longer needed. Systems utilizing PROM shall not be allowed.

E. The system shall provide a network communication facility to support global control strategies to be implemented in the distributed system. The system shall provide for events detected in any area of the total network. The system shall also provide for connected or calculated data to be continuously shared between any or all controllers within the total network.

F. DDC units shall be capable of being programmed to utilize programmed values for assured fail-safe operation of critical processes. Default values shall be invoked upon sensor failure or, if the primary value is normally provided by another DDC units, or by loss of bus communication. Individual application software packages shall also be structured to assume a fail-safe condition upon loss of input sensor. Loss of an input sensor shall result in a Sensor Failed message at the Router/Network Controller and the operator's terminal. After power failure and upon power restoration, the system shall provide automatic sequential restart of equipment based on current program time and program requirements without operator intervention.

G. Furnish and install all sensors, actuators, transducers, DDC units and central equipment to meet functional description and the I/O summary section as detailed in the plans and specifications.

H. DDC units shall be installed in control panels in each mechanical room and fan room as needed for system functionality. All wiring shall be in accordance with the National Electrical Code and all applicable Local Codes. System components requiring line voltage input shall be designed and tested to operate satisfactorily and without damage at 10% above and 15% below nominal rated voltage.

I. Use of an Optional Portable Operator's Terminal (POT): New DDC controls and additional DDC managed equipment shall be capable of allowing the use of and access by an optional owner Portable Operator's Terminal to Controllers or Router/Network Controllers connected to the Building Automation System.

J. All programming necessary to perform the required Sequence of Operation as specified shall be included with each stand-alone DDC controller. Testing and verification of performance is to be included. Any changes, additions and deletions to the Sequence of Operation or Programming as originally specified shall be an additional cost to the owner, and shall require prior approval for any deviation or change.

K. Graphic Screens necessary to represent each controlled piece of equipment shall be provided and displayed with set-point adjust, temperatures, on/off

status and control, as well as all points necessary to operate the equipment as specified in the sequence of operations from a Screen. These Graphic Screens shall be provided by the Controls Contractor and made available through the use of the Operator Workstation Computer or a remote terminal attached to the Ethernet Network through a Browser.

3.2 ROUTER/NETWORK CONTROLLERS

A. The Controller shall have available built-in services and hardware that will allow integration of LonMark/LonWorks and BACnet Controllers and Networks. Other major protocols, such as Modbus and DDE, as well as other Legacy and propriety based protocol converters, shall be available as options to the Router/Network Controller.

B. Full Internet Web Access features shall be available through a Browser and/or optional use of Engineering Access Software.

C. Communication shall be available through a 10/100 Mbit Ethernet RJ-45 Port Connection.

D. The core software shall utilize a real-time control engine based on a Java Virtual Machine implementation.

E. The Controller shall have a complete set of Java-based control applications, logging, and user interface “objects” included in a library for the Systems Integrator.

F. Global functions, object-oriented graphic screens, scheduling, alarming, simultaneous client workstations, and support for data linking over multiple networks, hosts, and controllers shall be fully supported at the controller.

G. RS-232 and RS-485 Serial ports shall be supported and available.

H. A Drag-and-drop graphical user interface approach shall be used for all standard services and software features. A Java-based Scripting Language, as well as a Compiled Java Language, shall be available for custom applications and software extensions.

I. The Controller shall have a wall or desktop mountable form factor, and shall be suitable for industrial locations.

J. The Router/Network Controller must be able to be managed by IT Administration through department networks via their administration software tools just as they manage other Windows PC’s on their LAN or WAN.

3.3 DDC CONTROLLERS

A. All DDC Controllers shall be BACNET compliant.

B. Complete interoperability will be assured through firmware and hardware that supports all mandatory and optional LonMark Standard Va riables Types (SNVTs) and provides ether a LonMark profile or a LonWorks XID File for each controller.

C. Custom applications shall provide published application source code, device resource files and external interface definitions.

D. DDC Controllers shall be working integrally with the stand-alone control application program.

E. DDC Controllers, such as application specific, large scale, unitary, or other size and configuration shall be the primary means used to control each defined task or equipment.

F. DDC Controllers shall be programmed from a drag-and drop user interface based programming software tool. Block or object orientation methods for organizing or representing programming shall be employed. No text-based, basic or line interpreted programming languages will be allowed.

G. All DDC Controllers shall be connected and accessible through a DDC Network directly interfaced with the Router/Network Controller. No additional converters, gateways, or routers shall be needed to connect the Router/Network Controller to the compliant DDC Controllers.

H. The installing Contractor shall perform all binding, addressing and configurations of the ATC Network and the DDC Controllers on the Network.

3.4 OPERATOR WORKSTATION COMPUTERS AND COMPATIBILITY

A. An Operator Workstation is required.

B. The computer shall be based upon a Pentium IV class microprocessor and the Windows 7 operating system.

C. It shall have a minimum 17” SVGA color monitor with minimum 16-bit color depth.

E. It shall be equipped with a current industry standard CD-ROM/DVD/RW Drive, and a Hard Drive all sized for the necessary workstation and application software. It shall be able to accommodate future expansion, upgrade, and additional software.

F. Standard serial, parallel, USB, and Ethernet Ports shall be included.

G. A Microsoft compatible keyboard and mouse shall be supplied and installed on the system.

H. An industry standard sound card, drivers, and speakers will be included with the system.
I. A reliable established Name-brand Company with full service and support available from the manufacturing firm or supplier shall manufacture the computer. Privately assembled computers or third party assemblers will not be acceptable as a manufacturer.

J. A standard full one (1) year warranty on parts and labor shall be provided.

K. All manuals for the computer and the install disks for each software package shall be provided, including manuals.

3.5 DDC INTELLIGENT WALL TEMPERATURE SENSOR/THERMOSTATS

A. DDC Intelligent Wall Sensors shall be integrally incorporated into the DDC architecture of the Controller.

B. They have a contemporary, low profile.

C. It shall have a communication port that allows a portable operator's terminal to access to the stand-alone controller it is attached to for monitoring of points and changing of key setpoint values.

3.6 SENSING AND CONTROL OUTPUTS REQUIREMENTS

A. Sensing inputs shall be provided via industry standard signals.

B. Temperatures, humidities, differential pressure signals, and all other signal inputs shall be one of the following types:

4-20 mA
0-5 VDC
0-12 VDC

C. Signal inputs shall be compatible with the controllers used, and with the requirement for readout of variables as specified.

D. Modulating outputs shall be industry standard 0-5 VDC, or 0-12 VDC.

E. Milli-amp outputs of 0-20 mA or 4-20 mA are also acceptable.

F. Temperature transmitters shall employ 1000-ohm platinum RTD sensing element with a DIN 43760 standard temperature coefficient. The transmitter shall have an adjustable operating range to allow field adjustment of the range to the specific application. The linearity and hysteresis of the sensor/transmitter system shall not exceed 0.1% of full scale, and the response time shall not exceed 400 microseconds. The transmitter shall have a 4 to 20 ma DC output, and shall operate from a power supply of 12 to 30 volts DC.

3.7 AIR DUCT SMOKE DETECTORS: (by Electrical Division 16000)

A. Smoke detectors shall be furnished and wired by Div. 16000 Electrical Contractor. The electrical contractor shall interlock all Smoke detectors with the building fire alarm system.

B. The air duct fire detector unit shall be listed by Underwriters' laboratories, Inc. The unit shall be designed for detection of combustion gases, fire and smoke in air conditioning and ventilating system ducts in compliance with the National Fire Protection Association Recommended Practices Pamphlet No. 90A. It shall consist of an ionization type detector with a self-contained control unit. The assembly shall consist of a casting to accommodate sampling tubes that extend across the duct of the ventilation system. While the fans are operating, flow thru the ionization detector, after which the sampled air shall be returned to the duct. The unit shall provide the following functions:

C. The unit shall operate from a two-wire 120 volt, 60 cycle power source and shall be operable over a range of 102-132 volts. The trouble circuit shall activate if the unit becomes inoperative due to low input voltage. The standby power consumption, excluding any external devices, shall not exceed one watt. The unit shall include power and alarm indicator lights. It shall have a key-operated momentary switch for resetting the unit.

D. Electrical contractor shall provide one set of normally open and one set of single pole double throw alarm operated relay contacts (5A., 120V., AC) at the building fire alarm panel.

E. ATC Contractor shall mount any and or all such smoke detectors.

3.8 VALVES

A. Automatic valves shall be available in either flanged or screwed connection. Valves 2" and smaller shall be screwed and larger valves shall be flanged. Screwed valves shall be rated at 150 psi and have cast iron, brass or steel bodies. Flanged valves shall be rated at 125-psi minimum and shall have cast iron or steel bodies. All two-way valves normally open or normally closed, shall be furnished with modulating plugs, which produce an equal percentage flow characteristic. Three-way mixing valves shall be furnished with equal percentage plugs.

B. Steam control valves shall be of the globe type and shall utilize a 1/3 and 2/3 arrangement. Hot water and cold water control valves may be of the ball type and the butterfly type.

C. All valves that are furnished for connection to the DDC Control System shall be equipped with electric/electronic actuators.

3.9 DAMPERS AND ACTUATORS

A. Automatic Dampers: The ATC Contractor shall furnish all automatic control dampers that are not furnished as part of the Air Handling Units. The Sheet Metal Contractor shall transition all ductwork to the dampers. All modulating dampers shall be parallel type and the blade width shall not exceed 8 inches. Dampers shall have butyl rubber blade and end seals with adjustable linkage to provide equal percentage characteristics. Linkage to be mounted inside channels of the frame. Bushings to be oil impregnated sintered bronze turning in nylon bearings. Frame of the damper to be drilled by the damper manufacturer to accommodate direct mounting to the damper operators. Leakage to be less than 1% with 2000 FPM and 6" w.g. static across the all dampers submitted shall show data to substantiate above specifications are met. Dampers shall be Ruskin CD50.

B. Damper Actuators: All actuators shall be sized to operate their appropriate dampers with sufficient reserve power to provide smooth action or two-position action as specified. When so specified in the sequence of operation where more than two actuators are to be operated in sequence.

C. Two position actuators shall be electric types. All damper actuators shall be provided with spring return mechanism. Electric damper actuators shall not be of the oil-immersed gear train or rotary type.

D. All damper actuators furnished for connection to the DDC Control System shall be electronic spring return type. Damper actuators for VAV boxes shall be electric or electronic, compatible with the DDC box controller, and shall provide modulating action of the dampers.

PART 4 - SEQUENCE OF OPERATIONS

4.01 CHILLED WATER SYSTEM

A. The DDC System shall enable and disable the Air Cooled Chiller. When enabled the chiller will operate under its factory-supplied controls to maintain the discharge water temperature as reset by the building energy management system.

B. The DDC System shall monitor the Chiller for run status and fault alarm.

C. When the outdoor temperature is above 68 degrees F (adj), the associated lead chilled water pump will start and run continuously whenever there is a call for cooling and in OCCUPIED mode. Modulate associated to main associated VFD DPS set point.

D. Each pump is sized for 100% of the system requirements.

E. While under DDC control, a rotation schedule shall be incorporated that provides for scheduled changes of the assigned lead and lag pumps. (Schedule to be determined by School Officials)

F. While under DDC Control, the lag chilled water pump will start and operate if the lead pump fails.

G. The chiller will not start unless at least one of the chilled water pumps is running and a paddle type water flow switch monitored by the DDC System has proved chilled water flow.

F. The DDC System shall monitor both supply and return chilled water temperatures.

E. The DDC system shall re-set the chilled water temperatures bas on demand. Intial re-set schedule shall be as follows:

OAT =68°F
CHWS= 48° F
OAT = 98° F
CHW= 42°F
(adjustable)

4.02 STEAM EXCHANGER AND HOT WATER SYSTEM

A. The heating hot water heat exchanger serves all Fan Coil Units and Air Handling Units.

B. Each pump is sized for 100% of the system requirements.

H. While under DDC control, a rotation schedule shall be incorporated that provides for scheduled changes of the assigned lead and lag pumps. (Schedule to be determined by School Officials)

C. While under DDC Control, the lag hot water, water pump will start and operate if the lead pump fails.

D. The steam to hot water heat exchanger steam valves will be closed if the hot water pumps are off. A temperature sensor, located in the hot water supply of the heat exchanger, through the DDC Controller, will modulate the 1/3 and 2/3 capacity, normally closed steam valves in sequence to maintain temperature setpoint as reset by outside air temperature according to the following schedule:

Outdoor Air Hot Water Supply Temperature
Temperature Setpoint
0.0 degrees F. 180.0 degrees F.
70 degrees F. 100.0 degrees F.

E. The temperature will not be reset above 180 degrees.

4.03 Variable Volume Air Handling Unit:

A. The air handling unit is a variable volume unit and consists of one supply fan, a hot water heating coil, chilled water cooling coil, and mixed air dampers (Return and Outside Air Dampers). The supply fans will be provided with variable speed drives (VFD). The sequence includes Discharge Air Temperature Control, OA temp Based Economizer, Mixed Air Low Limit Control, and Static Pressure Control. The unit shall be controlled though the BAS as follows:

B. Supply and Return Fan Control

1. The Building Automation System (BAS) will enable the supply fan on to run continuously under normal conditions, both occupied and unoccupied
2. Static Pressure Control. A static pressure sensor shall be located in the main supply duct approximately 2/3 of the length from the supply fan discharge. Upon supply fan startup, the BAS will ramp the variable speed drive until the static pressure reading matches the static setpoint (adjustable). The BAS shall modulate, using a 4-20 ma signal, the supply fan variable speed drive to maintain the duct static pressure to the static setpoint (adjustable).
3. Return fan shall modulate to maintain relief plenum static pressure setpoint of 0.15” (adj)
4. There shall be an averaging manual reset two position low limit thermostat placed directly before the first set of coils following the Mixed Air Dampers Section. The low limit thermostat shall have a manual setpoint of 40 Deg F. (adjustable). When the air discharging from the mixed air section drops below the low limit setpoint, the low limit thermostat will trip, the supply fan shall be shut down. The low limit thermostat will be wired directly to the supply fan variable frequency drive panel to shut the supply fan off. The BAS shall command the hot water valve open. A BAS alarm is generated whenever a low temperature condition is detected.
4. There shall be a manual reset smoke detector placed in the supply and return duct. When the smoke detector in the supply or return duct senses smoke, the supply fan shall be shut off. The smoke detectors will be wired directly to the supply fan variable frequency drive panel to shut the supply fan off. A BAS alarm is generated whenever a smoke condition is sensed.
5. When the BAS commands the supply fan off (manual override or for maintenance), the chilled water coil valves shall be commanded closed, the hot water coil valve shall be commanded close, the outdoor dampers shall be commanded closed and return air dampers shall be commanded open.
6. A BAS alarm is generated whenever the supply air fan fails to respond to on-off commands.

C. The supply air temperature setpoint will be re-set by OAT. Intial setpoints shall be: OAT = 55
SA= 55
OAT=5
SA=65

1. Control of Cooling:

   a. The controller will maintain supply air temperature.

   b. The controller will use OA temp to determine the correct cooling stage mode from the three stages of control as follows:
   c. Stage 1 - Economizer Mode:

      1) When the supply fan is operating, the outside air damper will be open to the minimum outside air ventilation position.
      2) If the outside air temperature is below the return air temperature, the outside air damper will modulate open past minimum position to take advantage of free cooling capacity, to maintain the supply air temperature setpoint.
      3) If the outside air temperature is above the return air temperature, the outside air damper will remain at minimum position.

   d. Stage 2 - Evaporative Cooling Mode:

      1) When outside air temperature is above 50 deg F. adjustable, the direct evaporative cooling stage shall be enabled.
      2) When direct evaporative cooling is enabled, the BAS shall open mixed air dampers to 100% outside air, close the auto drain valve, and open the auto fill valve. When system is unable to maintain discharge temperature set point I first stage of economizer cooling, BAS shall and cycle the direct evap. sump pump in order to maintain discharge temperature.
      3) Provide a building humidistat at each floor, and an air handler humidistat at the AHU outlet. Disable the direct evap. cooling stage if %RH at any building humidistat exceeds a high limit of 50% adjustable, or if the air handler humidistat exceeds a high limit of 90% RH adjustable.
      4) Auto flush and fill: The evap. cooling section shall have a solenoid valve on the fill line and the drain line. Each night during the cooling season, the system shall open the fill and drain valves to 100% for 1 hour adjustable to flush and drain the system. Adjust fill valve as necessary to prevent over flooding during flush and fill sequence. At the end of the flush and fill sequence, the fill valve shall shut, and the drain valve shall remain open unit the building is occupied.

e. Stage 3 –Cooling Mode:

1) The controller will modulate the chilled water control valve for the chilled water coil to maintain the air handler supply air temperature set-point.

D. Control of Heating:

1. When the supply fans are off, the BAS shall command the hot water coil control valve closed. When the supply fan status is on, the hot water valve shall operate according to the mode that air handling unit is in.

2. Heating Mode:

a. In the heating mode, the BAS shall modulate the hot water valve to maintain the air handler supply air temperature setpoint.

3. Economizer Mode: The BAS shall command the hot water valve closed.

4. Cooling Mode: The BAS shall command the hot water valve closed.

E. Mixed Air Control.

1. Mixed air dampers shall refer to the outdoor air dampers and return air dampers. The dampers shall be mechanically linked or have actuators set in a manner such that when the outdoor air dampers are 0 % open the return air dampers shall be 100% open. This will be referred to as mix air dampers closed. When the outdoor air dampers are 100% open, the return air dampers will be 0 % open. This will be referred to mix air dampers open. In between 0% and 100% will be a linear function.

2. The BAS shall use an averaging sensor in the mixed air plenum to maintain a minimum of 48 Deg F. (adjustable) mixed air temperature.

3. Outdoor Air Flow Control.

a. In the event the fan is commanded off, the BAS shall command the minimum outdoor air damper closed.
b. In the event the unit is commanded to restart, it will do so in the Space Precondition mode, the BAS shall command the minimum outdoor air damper closed.

F. Monitoring:

1. Averaging type temperature sensors (aluminum flexible probes approximately 20ft in length) shall be installed and monitored in the

immediate discharge for each heating or cooling coil in the air handling unit.

G. Points:

1. Analog Inputs

a. Discharge Air Temperature
b. Mixed Air Temperature
c. Outdoor Air Temperature (May be global)
d. Return Air Temperature
e. Pre-Filter Differential Pressure
f. Final-Filter Differential Pressure
g. Static Pressure
h. Supply Air Flow

2. Analog Outputs

a. Chilled Water Coil Control Valve
b. Hot Water Coil Control Valve
c. Mixed Air Damper Actuators
d. Supply Fan VFD Speed

3. Digital Inputs

a. Safety Shutdown Relay (Summarizes the following Alarms):

1) Low Temperature Limit Switch (Freeze protections)
2) Supply Air High Duct Static Pressure Limit
3) Supply Duct Smoke Detector
4)Return Duct Smoke Detector
5)Fire Alarm System Fan Shutdown Relay

b. Supply Fan Status (VFD)

4. Digital Outputs

a. Supply Fan Enable (VFD)

4.04 Variable Air Volume Terminals (VAV):

A. VAV with Reheat

1. Each variable air volume box consists of a room sensor, a supply damper with an over the shaft Direct Digital Controller, modulating integral damper motor with quick release, integral differential pressure sensor, Hot Water Reheat Coil, and a Flo-Cross 2 x 12 points averaging and signal amplifying air flow sensor. The temperature control shall utilize Proportional, Integral and Derivative (PID) algorithms. Each VAV box shall include maximum and minimum (cooling and heating) flow settings (CFM), Override, and Room

Temperature Control. The VAV box shall be controlled though the BAS as follows:

2. Unoccupied Mode (only as designated by the Engineer)

    a. When unoccupied VAV box shall control to unoccupied set points (adj.).
    b. If the room temperature falls below 60 Deg F. (adjustable), the BAS shall generate an alarm.

3. Occupied Mode (Normal for most situations)

    a. The BAS shall schedule the VAV to occupied mode. The central air handling unit must be running before the VAV will operate in the occupied mode.
    b. There shall be a cooling setpoint of 74 Deg F. (adjustable) and a heating setpoint of 70 Deg F. (adjustable). There shall be a 4 Deg F. (adjustable) between the heating and cooling setpoint.
    c. Cooling:

        1) The BAS shall modulate the VAV supply air damper to maintain room temperature of 74 Deg F. (adjustable) through the VAV room sensor as well as the BAS.
        2) The supply damper shall be modulated towards the maximum position as the room temperature rises above setpoint and shall be modulated towards the minimum position as the room temperature drops below the setpoint.

    d. The VAV shall operate independent of the supply air pressure.
    e. Ventilation:

        1) The VAV Box shall be considered in the ventilation mode when the room temperature is between the heating and cooling setpoint.
        2) The BAS shall modulate the VAV supply air damper to maintain the cooling minimum flow (CFM)to the room for air proper air quality.

    f. Heating:

        1) When the room temperature drops below the heating setpoint, the VAV Box shall be considered to be in the heating mode.
        2) The BAS shall modulate VAV supply air damper and HW control valve simultaneously to maintain the heating minimum flow (CFM).
        3) When the room temperature drops below the heating setpoint, the BAS shall modulate the hot water reheat valve and supply air damper to maintain the heating setpoint of 70 Deg F. (adjustable) through the VAV room

sensor as well as the BAS. The BAS shall start to open the hot water reheat valve when the room temperature drops below 71 Deg F.. The BAS shall modulate the hot water reheat valve to the full open position when the room temperature drops below the heating setpoint by 1 Deg F. (adjustable).

g. The BAS shall limit the maximum cooling setpoint to 78 Deg F. (adjustable) and the minimum cooling setpoint to 68 Deg F. (adjustable).
h. The BAS shall limit the maximum heating setpoint to 76 Deg F. (adjustable) and the minimum heating setpoint to 65 Deg F. (adjustable).
i. If the room temperature rises 2 Deg F. (adjustable) above the cooling setpoint, the BAS shall generate an alarm. If the room temperature drops 2 Deg F. (adjustable) below the heating setpoint, the BAS shall generate an alarm.

4. Override Capability

a. When a VAV is in the Unoccupied Mode and a button on the room sensor is pushed, the BAS shall place the VAV in the Occupied Mode for 120 minutes (adjustable). The BAS shall command the appropriate central air handling unit and central plant equipment to on to provide the overridden VAV with the necessary comfort.

5. VAV Room Sensor

a. The VAV Room Sensor shall provide room temperature value to the controller.
b. The VAV Room Sensor shall be supplied in the following manner:
c. LED indication of override state.

6. Relief Air Damper

a. BAS shall modulate relief air damper to maintain building static pressure of T0.03” sp (adj.)

7. Point List

a. Analog Inputs

1) Room Temperature
2) AI Override Time Remaining
3) VAV Box Velocity Pressure
4) VAV Box Supply Flow (CFM)

b. Analog Outputs

1) Hot Water Reheat Valve (May be 3-Point Floating from digital outputs)
2) AO VAV Supply Damper

c. Digital Inputs

1) Override Status

4.06 EXHAUST FANS

A. Exhaust fans shall be controlled through the DDC system to operate on a dedicated Occupied/Unoccupied schedule per fan. Fan Status shall be monitored by current switch.

B. Exhaust fan serving trash corridor and elevator equipment room shall be provided with a VFD. Fan shall have a dedicated daytime and a nighttime schedule, with a preset adjustable VFD speed. Initial set points shall be 100% daytime, and 50% night time. In addition, provide a space temperature sensor in the elevator equipment room. Upon a call for cooling in elevator equipment room, over-ride fan speed to 100% regardless of schedule until space temperature is satisfied.

4.07 DORMITORY ROOM FANCOIL UNITS

A. Fan Coil Units consist of a four-pipe hydronic system for heating and cooling, a supply fan, a filter, and factory dampers. These units shall be controlled by a thermostat with 3 position and adjustable temp setpoints. Coordinate with fan coil unit supplier.

B. This contractor shall provide install, and wire the programmable thermostat as located on the plans.

END OF SECTION 15900

SECTION 15950 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes TAB to produce design objectives for the following:

1. Air Systems: Depending on type of system designed by design/build team.

   a. Constant-volume air systems.
   b. Variable-air-volume systems.

2. Hydronic Piping Systems: Depending on type of system designed by design/build team.

   a. Constant-flow systems.
   b. Variable-flow systems.
   c. Primary-secondary systems.

3. Steam systems.
4. HVAC equipment quantitative-performance settings.
5. Smoke-control systems testing and adjusting.
6. Verifying that automatic control devices are functioning properly.
7. Reporting results of activities and procedures specified in this Section.

1.3 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.

C. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.

D. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

E. NC: Noise criteria.

F. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

G. RC: Room criteria.

H. Report Forms: Test data sheets for recording test data in logical order.

I. Smoke-Control System: An engineered system that uses fans to produce airflow and pressure differences across barriers to limit smoke movement.

J. Smoke-Control Zone: A space within a building that is enclosed by smoke barriers and is a part of a zoned smoke-control system.

K. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

L. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.

M. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

N. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

O. TAB: Testing, adjusting, and balancing.

P. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

Q. Test: A procedure to determine quantitative performance of systems or equipment.

R. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.4 SUBMITTALS

A. Qualification Data: Within 15 days from Contractor's Notice to Proceed, submit 4 copies of evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Sample Report Forms: Submit two sets of sample TAB report forms.

C. Warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. TAB Firm Qualifications: Engage a TAB firm certified by AABC or NEBB.

B. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."

C. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."

D. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.

1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

E. Approved TAB agencies:

1. Bonneville Test and Balance.
2. BTC Services.
3. Certified Test and Balance.
4. Intermountain Test and Balance.
5. RS Analysis.
6. Technical Specialties.
7. Testing and Balancing, Inc.
8. Prior approved equal.

1.6 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.7 WARRANTY

A. National Project Performance Guarantee: Provide a guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee includes the following provisions:

1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - PRODUCTS
(Not 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.

1. Contract Documents are defined in the General and Supplementary Conditions of Contract.
2. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine Project Record Documents described in Division 1 Section "Project Record Documents."

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. 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. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.

G. Examine system and equipment test reports.

H. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

J. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

K. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.

L. Examine strainers for clean screens and proper perforations.

M. Examine two and three-way valves for proper installation for their intended function.

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

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

P. Examine equipment for installation and for properly operating safety interlocks and controls.

Q. Examine automatic temperature system components to verify the following:

1. Dampers, valves, and other controlled devices are operated by the intended controller.
2. Dampers and valves are in the position indicated by the controller.
3. Integrity of all valves and all dampers for free and full operation and for tightness of fully closed and fully open positions.
4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
5. Thermostats are located to avoid adverse effects of sunlight, drafts, and cold walls.
6. Sensors are located to sense only the intended conditions.
7. Sequence of operation for control modes is according to the Contract Documents.
8. Controller set points are set at indicated values.
9. Interlocked systems are operating.
10. Changeover from heating to cooling mode occurs according to indicated values.

R. 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 strategies and step-by-step procedures.

B. Complete system readiness checks and prepare system readiness reports. Verify the following:

1. Permanent electrical power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so indicated conditions for system operations can be met.

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 Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.

C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, 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. Crosscheck the summation of required outlet volumes with required fan volumes.

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

C. For variable-air-volume systems, develop a plan to simulate diversity.

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

E. Check airflow patterns from the outside-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. Check for proper sealing of air duct system.

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 fan static pressures to determine actual static pressure as follows:

   a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
   b. Measure static pressure directly at the fan outlet or through the flexible connection.
   c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
   d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.

   a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.

3. Measure static pressures entering and leaving other devices such as sound traps under final balanced conditions.
4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
5. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.

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

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.

a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure terminal outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a maximum set-point airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.

B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set outside-air dampers at minimum, and return- and exhaust-air dampers at a position that simulates full-cooling load.
2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of

terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.

3. Measure total system airflow. Adjust to within indicated airflow.
4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems.

    a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.

6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.
7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
8. Record the final fan performance data.

C. Pressure-Dependent, Variable-Air-Volume Systems without Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Balance systems similar to constant-volume air systems.
2. Set terminal units and supply fan at full-airflow condition.
3. Adjust inlet dampers of each terminal unit to indicated airflow and verify operation of the static-pressure controller. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
4. Readjust fan airflow for final maximum readings.
5. Measure operating static pressure at the sensor that controls the supply fan, if one is installed, and verify operation of the static-pressure controller.
6. Set supply fan at minimum airflow if minimum airflow is indicated. Measure static pressure to verify that it is being maintained by the controller.
7. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems.

    a. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.

8. Measure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.

D. Pressure-Dependent, Variable-Air-Volume Systems with Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set system at maximum indicated airflow by setting the required number of terminal units at minimum airflow. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.
2. Adjust supply fan to maximum indicated airflow with the variable-airflow controller set at maximum airflow.
3. Set terminal units at full-airflow condition.
4. Adjust terminal units starting at the supply-fan end of the system and continuing progressively to the end of the system. Adjust inlet dampers of each terminal unit to indicated airflow. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
5. Adjust terminal units for minimum airflow.
6. Measure static pressure at the sensor.
7. Measure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.

3.7 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

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

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check expansion tank liquid level.
3. Check makeup-water-station pressure gage for adequate pressure for highest vent.
4. Check flow-control valves for specified sequence of operation and set at indicated flow.
5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.8 PROCEDURES FOR HYDRONIC SYSTEMS

A. Measure water flow at pumps. Use the following procedures:

1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for

differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.

2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
4. Report flow rates that are not within plus or minus 5 percent of design.

B. Set calibrated balancing valves, if installed, at calculated presettings.

C. Measure flow at all stations and adjust, where necessary, to obtain first balance.

1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

D. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

E. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:

1. Determine the balancing station with the highest percentage over indicated flow.
2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
3. Record settings and mark balancing devices.

F. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

G. Measure the differential-pressure control valve settings existing at the conclusions of balancing.

3.9 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.10 PROCEDURES FOR PRIMARY-SECONDARY-FLOW HYDRONIC SYSTEMS

A. Balance the primary system crossover flow first, then balance the secondary system.

3.11 PROCEDURES FOR STEAM SYSTEMS

A. Measure and record upstream and downstream pressure of each piece of equipment.

B. Measure and record upstream and downstream steam pressure of pressure-reducing valves.

C. Check the setting and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record the final setting.

D. Check the settings and operation of each safety valve. Record settings.

E. Verify the operation of each steam trap.

3.12 PROCEDURES FOR HEAT EXCHANGERS

A. Measure water flow through all circuits.

B. Adjust water flow to within specified tolerances.

C. Measure inlet and outlet water temperatures.

D. Measure inlet steam pressure.

E. Check the setting and operation of safety and relief valves. Record settings.

3.13 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer, model, and serial numbers.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

3.14 PROCEDURES FOR CHILLERS

A. Balance water flow to within specified tolerances of indicated flow with all pumps operating. Do not exceed the flow for the maximum tube velocity recommended by the

chiller manufacturer. Measure and record the following data with chiller operating at design conditions:

1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
2. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
3. Power factor if factory-installed instrumentation is furnished for measuring kilowatt.
4. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatt.
5. Capacity: Calculate in tons of cooling.
6. Verify condenser-fan rotation and record fan and motor data including number of fans and entering- and leaving-air temperatures.

3.15 PROCEDURES FOR BOILERS

A. If hydronic, measure entering- and leaving-water temperatures and water flow.

3.16 PROCEDURES FOR HEAT-TRANSFER COILS

A. Water Coils: Measure the following data for each coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

3.17 PROCEDURES FOR TEMPERATURE MEASUREMENTS

A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.

B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of two successive eight-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.

C. Measure outside-air, wet- and dry-bulb temperatures.

3.18 TEMPERATURE-CONTROL VERIFICATION

A. Verify that controllers are calibrated and commissioned.

B. Check transmitter and controller locations and note conditions that would adversely affect control functions.

C. Record controller settings and note variances between set points and actual measurements.

D. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).

E. Check free travel and proper operation of control devices such as damper and valve operators.

F. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.

G. Check the interaction of electrically operated switch transducers.

H. Check the interaction of interlock and lockout systems.

I. Check main control supply-air pressure and observe compressor and dryer operations.

J. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or nongrounded power supply.

K. Note operation of electric actuators using spring return for proper fail-safe operations.

3.19 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 5 to plus 10 percent.
2. Air Outlets and Inlets: 0 to minus 10 percent.
3. Heating-Water Flow Rate: 0 to minus 10 percent.
4. Cooling-Water Flow Rate: 0 to minus 5 percent.

3.20 FINAL REPORT

A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.

1. Include a list of instruments used for procedures, along with proof of calibration.

C. 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, but do not include Shop Drawings and Product Data.

D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:

1. Title page.
2. Name and address of TAB firm.
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 firm 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, type size, and fittings.
14. Notes to explain why certain final data in the body of reports varies from indicated values.
15. Test conditions for fans and pump performance forms including the following:

    a. Settings for outside-, 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.

E. 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 outside, 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.

F. Air-Handling Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data: Include the following:

   a. Unit identification.
   b. Location.
   c. Make and type.
   d. Model number and unit size.
   e. Manufacturer's serial number.
   f. Unit arrangement and class.
   g. Discharge arrangement.
   h. Sheave make, size in inches, and bore.
   i. Sheave dimensions, center-to-center, and amount of adjustments in inches.
   j. Number of belts, make, and size.
   k. Number of filters, type, and size.

2. Motor Data:

   a. 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. Sheave dimensions, center-to-center, 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. Cooling coil static-pressure differential in inches wg.
   g. Heating coil static-pressure differential in inches wg.
   h. Outside airflow in cfm.
   i. Return airflow in cfm.
   j. Outside-air damper position.
   k. Return-air damper position.

G. 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.
b. Average face velocity in fpm.
c. Air pressure drop in inches wg.
d. Outside-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. Inlet steam pressure in psig.

H. 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 Btuh.
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. Sheave dimensions, center-to-center, and amount of adjustments in inches.

2. Test Data (Indicated and Actual Values):

a. Low-fire fuel input in Btuh.
b. High-fire fuel input in Btuh.
c. Manifold pressure in psig.
d. High-temperature-limit setting in deg F.

e. Operating set point in Btuh.
f. Motor voltage at each connection.
g. Motor amperage for each phase.
h. Heating value of fuel in Btuh.

I. 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. Sheave dimensions, center-to-center, and amount of adjustments in inches.

2. Motor Data:

a. 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. Sheave dimensions, center-to-center, and amount of adjustments in inches.
g. Number of belts, make, and size.

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.

J. Round, Flat-Oval, 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.

K. Air-Terminal-Device Reports:

1. Unit Data:

a. System and air-handling unit identification.
b. Location and zone.
c. Test apparatus used.
d. Area served.
e. Air-terminal-device make.
f. Air-terminal-device number from system diagram.
g. Air-terminal-device type and model number.
h. Air-terminal-device size.
i. Air-terminal-device 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.

L. Packaged Chiller Reports:

1. Unit Data:

a. Unit identification.
b. Make and model number.
c. Manufacturer's serial number.
d. Refrigerant type and capacity in gal..
e. Starter type and size.
f. Starter thermal protection size.
g. Compressor make and model number.
h. Compressor manufacturer's serial number.

2. Air-Cooled Condenser Test Data (Indicated and Actual Values):

a. Refrigerant pressure in psig.
b. Refrigerant temperature in deg F.
c. Entering- and leaving-air temperature in deg F.

3. Evaporator Test Reports (Indicated and Actual Values):

a. Refrigerant pressure in psig.
b. Refrigerant temperature in deg F.

c. Entering-water temperature in deg F.
d. Leaving-water temperature in deg F.
e. Entering-water pressure in feet of head or psig.
f. Water pressure differential in feet of head or psig.

4. Compressor Test Data (Indicated and Actual Values):

a. Suction pressure in psig.
b. Suction temperature in deg F.
c. Discharge pressure in psig.
d. Discharge temperature in deg F.
e. Oil pressure in psig.
f. Oil temperature in deg F.
g. Voltage at each connection.
h. Amperage for each phase.
i. Kilowatt input.
j. Crankcase heater kilowatt.
k. Chilled-water control set point in deg F.
l. Condenser-water control set point in deg F.
m. Refrigerant low-pressure-cutoff set point in psig.
n. Refrigerant high-pressure-cutoff set point in psig.

5. Refrigerant Test Data (Indicated and Actual Values):

a. Oil level.
b. Refrigerant level.
c. Relief valve setting in psig.
d. Unloader set points in psig.
e. Percentage of cylinders unloaded.
f. Bearing temperatures in deg F.
g. Vane position.
h. Low-temperature-cutoff set point in deg F.

6. Pump Test Data (Indicated and Actual Values):

a. Voltage at each connection.
b. Amperage for each phase.
c. Water flow rate in gpm.

7. Water Test Data (Indicated and Actual Values):

a. Entering-water temperature in deg F.
b. Leaving-water temperature in deg F.
c. Water temperature differential in deg F.
d. Entering-water pressure in feet of head or psig.
e. Leaving-water pressure in feet of head or psig.
f. Water pressure differential in feet of head or psig.
g. Water flow rate in gpm.

8. Air Data (Indicated and Actual Values):

a. Duct airflow rate in cfm.
b. Inlet-duct static pressure in inches wg.
c. Outlet-duct static pressure in inches wg.
d. Average entering-air, wet-bulb temperature in deg F.
e. Average leaving-air, wet-bulb temperature in deg F.
f. Ambient wet-bulb temperature in deg F.

M. Heat-Exchanger/Converter Test Reports: For steam and hot-water heat exchangers, include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Service.
d. Make and type.
e. Model and serial numbers.
f. Ratings.

2. Steam Test Data (Indicated and Actual Values):

a. Inlet pressure in psig.
b. Condensate flow rate in lb/h.

3. Primary Water Test Data (Indicated and Actual Values):

a. Entering-water temperature in deg F.
b. Leaving-water temperature in deg F.
c. Entering-water pressure in feet of head or psig.
d. Water pressure differential in feet of head or psig.
e. Water flow rate in gpm.

4. Secondary Water Test Data (Indicated and Actual Values):

a. Entering-water temperature in deg F.
b. Leaving-water temperature in deg F.
c. Entering-water pressure in feet of head or psig.
d. Water pressure differential in feet of head or psig.
e. Water flow rate in gpm.

N. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Service.
d. Make and size.
e. Model and serial numbers.
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.

O. Boiler Test Reports:

1. Unit Data:

a. Unit identification.
b. Location.
c. Service.
d. Make and type.
e. Model and serial numbers.
f. Fuel type and input in Btuh.
g. Number of passes.
h. Ignition type.
i. Burner-control types.
j. Voltage at each connection.
k. Amperage for each phase.

2. Test Data (Indicated and Actual Values):

a. Operating pressure in psig.
b. Operating temperature in deg F.
c. Entering-water temperature in deg F.
d. Leaving-water temperature in deg F.
e. Number of safety valves and sizes in NPS.
f. Safety valve settings in psig.
g. High-limit setting in psig.
h. Operating-control setting.

i. High-fire set point.
j. Low-fire set point.
k. Voltage at each connection.
l. Amperage for each phase.
m. Draft fan voltage at each connection.
n. Draft fan amperage for each phase.
o. Manifold pressure in psig.

3.21 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the Final Report.
2. Randomly check the following for each system:

   a. Measure airflow of at least 10 percent of air outlets.
   b. Measure water flow of at least 5 percent of terminals.
   c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
   d. Verify that balancing devices are marked with final balance position.
   e. Note deviations to the Contract Documents in the Final Report.

B. Final Inspection:

1. After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Owner.
2. TAB firm test and balance engineer shall conduct the inspection in the presence of Owner.
3. Owner shall randomly select measurements documented in the final report to be rechecked. The rechecking shall be limited to either 10 percent of the total measurements recorded, or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If the rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
6. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.
7. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

3.22 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional testing and balancing 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 testing, inspecting, and adjusting during near-peak summer and winter conditions.

END OF SECTION 15950

SECTION 16001 - ELECTRICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1. RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section. Architectural, Structural, Mechanical and other applicable documents are considered a part of the electrical documents.

1.2. DESCRIPTION OF WORK: Extent of electrical work is indicated on drawings and/or specified in Division 16 section. Work includes.

	ITEM	SECTION
1.	Electrical General Provisions	16001
2.	Electrical Connections for Equipment	16070
3.	Electrical Seismic Control	16071
4.	Demolition	16080
5.	Conduit Raceways	16110
6.	Raceway Systems	16111
7.	Conductors and Cables	16120
8.	Medium Voltage Cable Splices, Terminators and Connectors	16122
9.	Electrical Boxes and Fittings	16135
10.	Supporting Devices	16136
11.	Wiring Devices	16140
12.	Motor Starters	16155
13.	Variable Frequency Drives (VFD's)	16156
14.	Panelboards	16160
15.	Motor and Circuit Disconnects	16170
16.	Switchgear and Switchboards	16175
17.	Medium Voltage Switches and Switchgear	16176
18.	Overcurrent Protective Devices	16180
19.	Transformers	16181
20.	Motor Control Centers	16183
21.	Power Factor Correction	16184
22.	Protective Device Study	16185
23.	Electrical Identification	16195
24.	Manholes	16400
25.	Service Entrance	16420
26.	Grounding	16452
27.	Interior and Exterior Building Lighting	16510
28.	Exterior Area Lighting	16551
29.	Lighting Control Equipment	16560
30.	Occupancy Sensors	16561
31.	Surge Protective Devices (SPD's)	16600
32.	Emergency Electrical Systems	16610
33.	Fire Alarm and Detection System	16721
34.	Telephone/Data Systems	16741
35.	Closed Circuit Television (CCTV)	16770
36.	Television Systems	16781
37.	Security Systems	16783

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38. Sound Reinforcement and Playback Systems 16785
39. Clock System 16786

1.3. INTERPRETATION OF DRAWINGS AND SPECIFICATIONS: Before bidding, Contractor shall familiarize himself with the drawings, specifications and project site.

1.4. QUALITY ASSURANCE: Comply with requirements of State and Local Ordinances. Obtain all permits, inspections, etc. Include all fees in bid. Employ only qualified craftsmen with at least three years of experience. Contractor shall have a current state contractor license.

1.5. SUBMITTALS:

A. SHOP DRAWINGS AND PRODUCT DATA: Prepare complete Shop Drawings and Brochures for materials and equipment. Submit 8 complete sets. Verify all dimensional information.

B. OPERATION AND MAINTENANCE MANUALS: Provide operating instruction and maintenance data books for all equipment and materials. Include complete cleaning and servicing data. Show serial numbers of each piece of equipment, complete lists of replacement parts, motor ratings, etc.

1.6. RECORD DRAWINGS:

A. Maintain, on a daily basis.

B. Record dimensions clearly and accurately, delineating the work as installed; identify locations by at least two dimensions to permanent reference points.

C. GUARANTEE: Replace any work or materials which develop defect, within one year.

PART 2 - PRODUCTS

2.1. GENERAL:

A. Products are specified by manufacturer name, description, and/or catalog number.

B. MANUFACTURERS: Provide products of manufacturers specified. Substitutions will be considered if a duplicate written application (2-copies) is submitted.

C. No materials or apparatus may be substituted after the bid opening.

D. Provide block-outs, sleeves, demolition work, etc., required for installation of work specified in this division.

2.2. CLEAN:

A. Clean up all equipment, conduit, fittings, packing cartons and other debris.

B. Clean fixtures, interiors and exteriors of all equipment, and raceways.

2.3. POWER OUTAGES:

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A. All power outages required for execution of this work shall occur during non-standard working hours and at the convenience of the Owner. Include all costs for overtime work in bid.

B. Major utility outages shall occur between July 1st and August 5th.

2.4. STORAGE AND PROTECTION OF MATERIALS:

A. Provide storage space for storage of materials and apparatus and assume complete responsibility for all losses.

2.5. EXCAVATING FOR ELECTRICAL WORK:

A. General: Locate and protect existing utilities and other underground work. Perform excavation in a manner which protects walls, footings, and other structural members.

2.6. CONCRETE BASES:

A. Provide 4" high concrete bases for electrical equipment.

2.7. ROOF PENETRATIONS:

A. Provide roof jack, sized to fit thightly to raceway for weathertight seal.

2.8. FIRE PENETRATION SEALS:

A. Seal all penetrations for work of this section through fire rated floors, walls and ceilings.

2.9. PROJECT FINALIZATION AND START-UP:

A. Assemble all equipment Factory Representatives and Subcontractors for system start-up.

B. Give personal instruction on operating and maintenance of their equipment to the Owner's maintenance and/or operation personnel.

2.10. FINAL REVIEW:

A. Project foreman shall accompany the reviewing party, and remove coverplates, panel covers and other access panels to allow review of the entire electrical system.

END OF SECTION 16001

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SECTION 16070 - ELECTRICAL CONNECTIONS FOR EQUIPMENT

PART 1– GENERAL

1.1. DESCRIPTION OF WORK:

A. Includes final electrical connection of all equipment having electrical requirements.

1.2. QUALITY ASSURANCE:

A. NEC Compliance and UL labels required.

PART 2 - PRODUCTS

2.1. GENERAL: Complete assembly of materials, including raceways, conductors, cords, cord caps, wiring devices, pressure connectors, terminals (lugs), electrical insulating tape, heat-shrinkable insulating tubing, cable ties, solderless wire nuts, and other items and accessories as needed to complete splices, terminations, and connections.

A. Permanently installed fixed equipment - flexible seal-tite conduit or raceway; to equipment; all wiring in raceway.

B. Movable and/or portable equipment - wiring device, cord cap, and multi-conductor cord suitable for the equipment.

C. Other methods as required by the National Electrical Code and/or as required by special equipment or field conditions.

PART 3 – EXECUTION

3.1. INSTALLATION OF ELECTRICAL CONNECTIONS:

A. In accordance with connector manufacturer's written instructions and with recognized industry practices.

B. Coordinate with equipment installation work.

C. Verify all electrical loads for equipment furnished under other Divisions.

D. Obtain and review the equipment shop drawings to determine particular final connection requirements.

END OF SECTION 16070

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SECTION 16071 - ELECTRICAL SEISMIC CONTROL

PART 1 – GENERAL

1.1 WORK INCLUDED:

A. Anchorage and seismic restraint systems for all Division 16 isolated and non-isolated equipment, cable tray, and conduit systems.

B. Equipment/cable tray/conduit to isolated and/or seismically supported shall include but not be limited to the following:

1. Conduit
2. Cable Tray
3. Light Fixtures

1.2 RELATED WORK:

A. Requirements: Provide Electrical Seismic Control in accordance with the Contract Documents.

B. Section 16001 – Electrical General Provisions

1.3 REFERENCES:

A. International Building Code, Current Edition in use by Jurisdictional Authority.

B. NFPA Bulletin 90A, Current Edition.

C. UL Standard 181.

1.4 SYSTEM DISCRIPTION

A. The Division 16 Contractor shall be responsible for supplying and installing equipment, vibration isolators, flexible connections, rigid steel frames, anchors, inserts, hangers and attachments, supports, seismic snubbers and bracing to comply with the following:

1. Short period design spectral response acceleration coefficient S_{DS}=0.70.
2. One second period design spectral response acceleration coefficient S_{D1}=0.28.
3. Site Class B.
4. Seismic Design Category D.

1.5 QUALITY ASSURANCE:

A. All supports, hangers, bases, anchorage and bracing for all isolated equipment and non-isolated equipment shall be designed by a professional engineer licensed in the state where the project is located, employed by the restraint manufacturer, qualified with seismic experience in bracing for electrical equipment. Shop drawings submitted for earthquake bracing and anchors shall bear the Engineer's signed professional seal. All

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calculations/design work required for the seismic anchorage and restraint of all Division 16 equipment and systems shall be provided by a single firm.

B. The above qualified seismic engineer shall determine specific requirements for equipment anchorage and restraints, locations and sizes based on shop drawings for the electrical equipment which have been submitted, reviewed and accepted by the Architect/Engineer for this project.

C. Seismic Engineer or the Engineer's Representative shall field inspect final installation and certify that bracing and anchorage are in conformance with the Seismic Engineer's design. A certificate of compliance bearing the Seismic Engineer's signed Professional Engineer's seal shall be submitted and shall be included in each copy of the Operation and Maintenance Manuals.

D. The Division 16 Contractor shall require all equipment suppliers furnish equipment that meets the seismic code, with bases/skids/curb designed to receive seismic bracing and/or anchorage. All isolated and non-isolated electrical equipment bracing to be used in the project shall be designed from the Equipment Shop Drawings and certified correct by the equipment manufacturer for seismic description listed in Paragraph 1.4 above, with direct anchorage capability.

PART 2 – PRODUCTS:

2.1 RESTRAINT EQUIPMENT AND SYSTEMS:

A. Manufacture and design of restraints and anchors for isolated equipment shall be by the manufacturer of the vibration isolators furnished for the equipment.

PART 3 – EXECUTION

3.1 DESIGN AND INSTALLATION:

A. General:

1. All electrical equipment cable tray and conduit shall be braced, anchored, snubbed or supported to withstand seismic disturbances in accordance with the criteria of this specification. Provide all engineering, labor, materials, and equipment for protection against seismic disturbances as specified herein. The following electrical components are exempt from seismic restraint requirements.

B. Spring Isolated Equipment:

1. All vibration isolated equipment shall be mounted on rigid steel frames or concrete bases as described in the vibration control specifications unless the equipment manufacturer certified direct attachment capability. Each spring mounted base shall have a minimum of four all-directional seismic snubbers that are double acting and located as close to the vibration isolators as possible to facilitate attachment both to the base and the structure. Snubbers shall be installed with factory set clearances.

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C. Non-Isolated Equipment:

1. The Division 16071 Contractor shall be responsible for thoroughly reviewing all drawings and specifications to determine all equipment to be restrained. This Contractor shall be responsible for certifying that this equipment is mounted and braced such that it adheres to the system description criteria in part 1.04 of this specification section.

D. Conduit:

1. Seismic braces for conduit may be omitted when the distance from the top of the conduit to the supporting structure is 12” or less.
2. A rigid conduit system shall not be braced to dissimilar parts of a building or two dissimilar building systems that may respond in a different mode during an earthquake. Examples: Wall and a roof; solid concrete wall and a metal deck with lightweight concrete fill.
3. Unbraced conduit attached to in-line equipment shall be provided with adequate flexibility to accommodate differential displacements.
4. At the interface of adjacent structures or portions of the same structure that may move independently, utility lines shall be provided with adequate flexibility to accommodate the anticipated differential movement between the ground and the structure.
5. Provide large enough pipe sleeves through wall or floors to allow for anticipated differential movements.

E. Cable Tray:

1. Seismic restraints are not required for cable tray with importance factor I_P of 1.0, provided that the following condition is met for the full length of each cable tray.

   a. Cable trays are suspended from rod hangers and hangers that are 12” or less in length from the point rod attaches to tray, to the point rod connects to the supporting structure. Rods must be secured to both top and bottom cross angles with locking nuts above and below angle iron.

END OF SECTION 16071

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SECTION 16080 - DEMOLITION

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Special Provisions, Division 1 and Division-2 Specification sections, apply to work of this section.

B. This section is a Division-16 Basic Materials and Methods section, and is part of each Division-16 section making reference to demolition.

1.2 DESCRIPTION OF WORK:

A. Extent of major items of demolition work is indicated by drawings. Other demolition work shall be performed as required to maintain system operation.

B. The intent of the drawings is to indicate major items affected and not to show every device, outlet, fixture, etc. affected by demolition work.

C. The drawings do not necessarily reflect as-built conditions. The contractor shall visit the jobsite prior to bidding to determine the overall scope of demolition work.

D. Refer to sections of other Divisions for applicable requirements affecting demolition work.

E. Refer to Section 16001 for requirements with regard to power outages affecting the operation of existing electrical systems.

1.3 QUALITY ASSURANCE:

A. NEC COMPLIANCE:

1. Comply with applicable portions of NEC as to methods used for demolition work.

PART 2 - PRODUCTS

2.1 GENERAL:

A. Demolition work shall be laid out in advance to eliminate unnecessary cutting, drilling, channeling, etc. Where such cutting, drilling, or channeling becomes necessary, perform with care, use skilled mechanics of the trades involved.

2.2 PATCHING AND REPAIR

A. The Contractor is responsible for all demolition, patching and repair of all finished interior surfaces pertaining to the installation of this particular phase of work.

B. Hard surfaces: Whenever demolition or excavation is required for the installation of the electrical system, it shall be the responsibility of this contractor to make repairs and/or replacements of hard finish surfaces such as concrete, asphalt, roofing, etc.

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C. The method of patching and repair shall follow good construction practices and all finished surfaces shall match materials and finish wherein the demolition occurred.

2.3 EXISTING EQUIPMENT

A. The following is a part of this project and all costs pertaining thereto shall be included in the base bid.

B. The new electrical equipment and apparatus shall be coordinated and connected into the existing system as required. Auxiliary systems shall comply, unless otherwise specified.

C. The existing electrical devices, conduit and/or equipment that for any reason obstructs construction shall be relocated. Provide conduit, wiring, junction boxes, etc. as required to extend existing circuits and systems to relocated devices or equipment.

D. Maintain circuit integrity and continuity of all existing circuits and systems that interfere with or are interrupted by remodel work unless those circuits are to be abandoned completely. Maintain all circuits and systems in operation during construction. Provide temporary panels, temporary wiring and conduit, etc. as required.

E. Any and all equipment having electrical connections that require disconnecting and reconnection at the same or another location throughout the course of construction shall be included as part of this contract.

END OF SECTION 16080

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SECTION 16110 - CONDUIT RACEWAYS

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK:

A. Types of raceways:

1. Electrical Metallic Tubing
2. Flexible Metal Conduit
3. Intermediate Metal Conduit
4. Liquid-tight Flexible Metal Conduit
5. Rigid Metal Conduit
6. Rigid Non-metallic Conduit

1.2. QUALITY ASSURANCE:

A. MANUFACTURERS: Firms regularly engaged in manufacture raceway systems for not less than three (3) years.

B. STANDARDS: NEMA and NEMA standards, UL safety standards and UL listed and labeled.

PART 2 - PRODUCTS

2.1. METAL CONDUIT AND TUBING:

A. GENERAL: Metal conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) as indicated; with minimum trade size of 1/2".

PART 3 - EXECUTION

3.1. INSTALLATION OF ELECTRICAL RACEWAYS:

A. Install electrical raceways where indicated; in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA "Standard of Installation", and in accordance with the following.

B. SERVICE ENTRANCE CONDUCTORS: Install in rigid metal conduit (RMC), or intermediate metal conduit (IMC); except where buried below grade, install in non-metallic conduit or duct, individually encased in concrete.

C. FEEDERS UNDER 600 VOLTS: Install feeders to panels and motor control centers and individual equipment feeders rated 100 amps and greater, in rigid metal conduit (RMC), or intermediate metal conduit (IMC); except where buried below grade, install in non-metallic conduit or duct. Encase feeders 1-1/4" and larger, individually in concrete where installed below slab-on-grade, or below grade. See duct banks.

D. BRANCH CIRCUITS, SIGNAL AND CONTROL CIRCUITS, AND INDIVIDUAL EQUIPMENT CIRCUITS RATED LESS THAN 100 AMPS: Install in electric metallic

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tubing (EMT). Except in poured walls, below concrete slab-on-grade, or in earth fill, install in non-metallic plastic duct. Encase non-metallic duct 1-1/4" and larger in concrete. See duct banks.

E. Provide expansion fittings on all conduits crossing buildings expansion joints.

F. DUCTBANKS: Provide ductbank construction as indicated using 3000 psi concrete with red marker dye. Install #4 reinforcing bar in each corner of ductbank. Provide minimum 4" concrete cover on all sides of exterior conduits.

G. ELECTRICAL IDENTIFICATION: Refer to Section 16195 for requirements.

END OF SECTION 16110

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SECTION 16111 - RACEWAY SYSTEMS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

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

B. This section is a Division-16 Basic Materials and Methods section, and is part of each Division-16 Section making reference to electrical raceways specified herein.

1.2 DESCRIPTION OF WORK:

A. Extent of raceways is indicated by drawings and schedules.

B. Types of raceways in this section include the following:

1. Cable tray systems

1.3 QUALITY ASSURANCE:

A. STANDARDS:

1. Comply with applicable portions of NEMA standards pertaining to raceways. Comply with applicable portions of UL safety standards pertaining to electrical raceway systems; and provide products and components which have been UL-listed and labeled. Comply with NEC requirements as applicable to construction and installation of raceway systems.

PART 2 - PRODUCTS

2.1 MANUFACTURED RACEWAY SYSTEMS:

A. GENERAL:

1. Provide electrical raceways of types, grades, sizes, weights [wall thicknesses], and number of channels, for each service indicated. Provide complete assembly of raceway including, but not necessarily limited to, couplings, offsets, elbows, expansion joints, adapters, holddown straps, end caps, and other components and accessories as needed for complete system.

B. CABLE TRAY SYSTEMS:

1. Provide UL-listed tray systems of sizes, types and capacities indicated, and meeting all requirements of NEMA VE-1. Trays to be provided include but are not necessarily limited to the following: Aluminum tray with solid bottom.

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PART 3 - EXECUTION

2.2 INSTALLATION OF ELECTRICAL RACEWAYS:

A. Install electrical raceways where indicated; in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA "Standard of Installation", and complying with recognized industry practices.

B. Coordinate with other work including metal and concrete deck work, as necessary to interface installation of electrical raceways and components.

C. Level and square raceway runs, and install at proper elevations/heights.

2.3 ADJUSTING AND CLEANING:

A. Upon completion of installation of raceways, inspect interiors of raceways; remove burrs, dirt and construction debris.

END OF SECTION 16111

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SECTION 16120 - CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK:

A. Types of conductors and cables include:

1. Copper Conductors (600V)
2. Copper Conductors (15KV)

B. Applications for conductors and cables required for project include:

1. Power Distribution Service
2. Feeders
3. Branch Circuits

1.2. QUALITY ASSURANCE:

A. Comply with NEC and NEMA. Provid UL-listing and label.

1.3. SUBMITTALS:

A. PRODUCT DATA: Submit manufacturer's data on electrical cable and connectors for use above 600 volts.

B. FIELD TEST DATA: Submit test data in accordance with IEEE Standard 400-1980 showing ambient conditions, voltage levels, level durations, and conduction current for each step for cable for use above 600 volt.

C. WORKMEN'S COMPETANCY: Submit medium voltage cable Splicer/Terminator certification of competency and experience 20 days before splices or terminations are made in medium voltage cables.

PART 2 - PRODUCTS

2.1. COPPER CONDUCTORS (600V):

A. Service Entrance Conductors – Copper conductor.

B. Distribution and Panelboard Feeders; and Other Conductors, #2 AWG and Larger – Copper conductor.

C. Branch Circuit Conductors and All Conductors #3 AWG and Smaller - Copper conductor, with TW, THHN, or THWN insulation #10AWG and smaller, and THW larger than #10AWG, and where ambient temperature conditions exceed 60 degrees C.Provide stranded conductors for #8 AWG and larger, use THHN in dry areas; in damp locations, under slab, on exterior, etc, use THWN. Minimum size #12 AWG.

D. Provide seperate neutral conductor for all three circuit home runs.

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2.2. COPPER CONDUCTORS (15V):

A. GENERAL: Provide 1/c type MV90, copper, 133 percent level, ethylene propylene insulated, shielded, jacketed power cable, conforming to current standards and revisions of ICEA S-68-516, IEEE 282, AEIC -CS6, UL 1072, and ASTM B-8, B231, where applicable.

B. CONDUCTOR: Construct with Class B stranding, concentric or compressed round, soft annealed copper.

C. INSULATION: Use extruded, semicon, thermoset, EPR compound. Provide color contrasting ethylene propylene.

D. CONDUCTOR SCREEN: Provide extruded layer of semiconducting EPR thermosetting compound.

E. CONDUCTOR SCREEN: Provide extruded layer of semiconducting EPR thermosetting compound.

F. INSULATION SHIELDING: Construct shielding utilizing 5 mil copper tape applied with a minimum 12-1/2 percent overlap.

G. JACKET: Construct of black chlorinated or chlorosulfonated polyethylene where used indoors, exposed, in cable tray, or in raceway. Construct of PVC where used in underground raceway, or ducts, or direct burial.

2.3. SPLICES AND TERMINATIONS:

A. General. Splice and terminate cables as indicated on drawings. Furnish splicing material (premolded or splicing kit) as recommended by cable manufacturer.

B. Stress Cone. Provide stress cones of either wrapped tape construction of preformed rubber cone with semiconducting inlay for shield termination; to form Class I terminations in accordance with IEEE Standard 48.

PART 3 - EXECUTION

3.1. INSTALLATION:

A. General: Comply with manufacturer's written instructions and in accordance with recognized industry practices.

3.2. FIELD QUALITY CONTROL:

A. Test cable and wire for continuity and for short circuits. For cable rated above 600 volts perform complete acceptance testing before energizing in accordance with IEEE Standard 400-1980.

3.3. ELECTRICAL IDENTIFICATION: Refer to Section 16195 for requirements.

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END OF SECTION 16120

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SECTION 16122 - MEDIUM VOLTAGE CABLE SPLICES, TERMINATORS, AND CONNECTORS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

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

B. Division-16 Basic Materials and Methods sections apply to work of this section except as otherwise indicated.

1.2 DESCRIPTION OF WORK:

A. Provide complete material, fabrication, installation, and testing for splicing, terminating, and connecting of all medium voltage cables.

1.3 QUALITY ASSURANCE:

A. Provide products which have been designed, manufactured, and tested in accordance with applicable industry standards.

B. Utilize only workers with demonstrated experience in splicing and terminating medium voltage cables. Submit evidence of workers' competency and proceed with work only after receiving approval from the Owner of individual workers scheduled to perform the work.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS: AS SPECIFIED

2.2 EQUIPMENT SECTIONS AND COMPONENTS:

A. GENERAL:

1. Except as otherwise indicated, provide splices, terminators and connectors of types, sizes, characteristics, and ratings indicated, which comply with manufacturer's standard design, materials, components, and construction in accordance with published product information, and as required for a complete installation.

2.3 15kV SPLICING SYSTEMS FOR TAPE SHIELDED CABLES:

A. Provide heat-, or cold-applied splicing systems suitable for installation in the underground duct bank system as well as for submersible and direct burial applications. Splices shall be capable of continuous operation at voltages up to 15kV and at ampere rating equivalent to 105 degree C ampere rating of cable, with emergency overload rating of 140 degrees C. Provide complete kits containing all necessary materials required to make splices, including preparation kits with solvent, cloth rags, and abrasive.

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2.4 15kV STRESS CONE CABLE TERMINATION SYSTEMS FOR TAPE SHIELDED CABLES:

A. Provide heat- or cold- applied termination systems suitable for installation in indoor switchgear assemblies and equipment enclosures. Provide weather shields in outdoor applications. Terminators shall be capable of continuous operation at voltages up to 15kV, and at ampere rating equivalent to 105 degree C rating of cable, with emergency overload rating of 140 degrees C. Provide complete kits containing all necessary materials required to make terminations, including preparation kits with solvent, cloth rags, and abrasive.

PART 3 - EXECUTION

3.1 INSTALLATION OF SPLICES, TERMINATORS, AND CONNECTORS:

A. Install splices, terminators and connectors in accordance with manufacturer's written instructions and with recognized industry practices to ensure that work complies with requirements of NEMA and NEC standards, and applicable portions of NECA's "Standard of Installation".

3.2 ACCEPTANCE TESTING:

A. Provide testing or splices, terminators, and connectors in accordance with NETA guidelines. Submit reports of completed tests to Owner before energizing cable.

END OF SECTION 16122

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SECTION 16153 - ELECTRICAL BOXES AND FITTINGS

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK:

A. Types of electrical boxes and fittings in this section include the following:

Outlet Boxes	Miscellaneous Boxes and Fittings
Knockout closures	Locknuts
Junction Boxes	Bushings
Pull Boxes	Conduit Bodies
Floor Boxes	

1.2. QUALITY ASSURANCE:

A. Comply with NEC AND ANSI. Provide UL label.

PART 2 - PRODUCTS

2.1. FABRICATED MATERIALS:

A. INTERIOR OUTLET BOXES: One piece, galvanized flat rolled sheet steel minimum depth 1-1/4".

B. WEATHERPROOF OUTLET BOXES: Corrosion-resistant cast-metal weatherproof outlet wiring boxes.

C. JUNCTION AND PULL BOXES: Code-gage sheet steel junction and pull boxes, with screw-on covers; of types, shapes and sizes to suit each respective location and installation;equipped with stainless steel nuts, bolts, screws and washers.

D. FLOOR BOXES: Cast-iron waterproof adjustable floor boxes.

E. CONDUIT BODIES: Galvanized cast-metal conduit bodies, of types, shapes and sizes to suit respective locations and installation, construct with threaded-conduit-entrance ends, removable covers, and corrosion-resistant screws.

F. BUSHINGS, KNOCKOUT CLOSURES AND LOCKNUTS: Corrosion-resistant punched-steel box knockout closures, conduit locknuts and malleable iron conduit bushings and offset connectors.

PART 3 - EXECUTION

3.1. INSTALLATION OF ELECTRICAL BOXES AND FITTINGS:

A. GENERAL: Comply with recognized industry practices. Provide coverplates for all boxes, weatherproof outlets for locations exposed to moisture, knockout closures to cap unused knockout holes, and install to ensure accessiblity. Fasten boxes rigidly to substarters or embed in concrete or masonry.

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END OF SECTION 16135

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SECTION 16136 - SUPPORTING DEVICES

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK: Include supports, anchors, sleeves and seals required for raceway support system.

1.2. QUALITY ASSURANCE: Comply with NEC. Provide UL label.

PART 2 - PRODUCTS:

2.1. SUPPORTING DEVICES

A. Complying with manufacturer's standard materials, design and construction in accordance with published product information, and as required for a complete installation.

PART 3 - EXECUTION

3.1. INSTALLATION OF SUPPORTING DEVICES:

A. Install in accordance with manufacturer's instructions and with recognized industry practices.

3.2. RACEWAYS: Support raceways in accordance with the following:

NUMBER OF RUNS	3/4" TO 1-1/4"	1-1/2" & LARGER 0
1	Full straps, clamps	Hanger or hangers.
2	Full straps, clamps	Mounting Channel or hangers.
3 or more	Mounting Channel	Mounting Channel

A. Do not use "tie wire". Do not support raceway from ceiling support wires.

3.3. FLOOR MOUNTED EQUIPMENT: Provide rigid attachment of all floor slab or strucutural system.

3.4. CABLE TRAYS: Provide vertical and lateral support systems.

END OF SECTION 16136

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SECTION 16140 - WIRING DEVICES

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK:

A. Types include:

1. Receptacles
2. Switches
3. Dimmer controls
4. Cord caps
5. Cord connectors
6. Floor service outlets

1.2. QUALITY ASSURANCE:

A. Comply with NEC and NEMA standards. UL listing and label.

1.3. SUBMITTALS:

A. PRODUCT DATA: Submit manufacturer's data.

PART 2 - PRODUCTS

2.1. FABRICATED WIRING DEVICES:

A. Provide wiring devices of proper voltage rating. Manufacturer as specified.

B. Provide hospital grade devices and tamper proof devices where indicated.

C. GROUND-FAULT INTERRUPTER: Provide general-duty, duplex receptacle, ground-fault circuit interrupters.

D. WEATHER-RESISTANT RECEPTACLES: Provide weather resistant receptacles in outdoor locations.

E. CORD CAPS AND CONNECTORS: Provide 3-wire grounding, cap plugs, and connectors of ampere and voltage rating required.

F. INCANDESCENT LAMP DIMMERS: Provide branch lighting solid-state AC dimmer controls for incandescent fixtures; wattage and voltage as indicated.

G. FLUORESCENT LAMP DIMMERS: Single-pole, semi-conductor modular type AC dimmers for fluorescent fixtures; continuously adjustable slider control, and with electromagnetic filters to reduce noise and interference to minimum.

2.2. WIRING DEVICE ACCESSORIES:

A. WALL PLATES: Plate color to match wiring devices, stainless steel coverplates in all

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finished areas.

B. WEATHER PROTECTIVE DEVICES ENCLOSURES. Provide weather protective device enclosure in compliance with NEC 406-8.

C. FLOOR SERVICE OUTLETS: Leveling and fully adjustable with finish as selected by Architect.

D. POKE-THROUGH ASSEMBLY DEVICES: Factory-assembled poke-through assembly devices equipped with wiring devices.

PART 3- EXECUTION

3.1. Comply with manufacturer's instructions and recognized industry practices.

3.2. TESTING: Test for continuity and proper polarity connections.

3.3. ELECTRICAL IDENTIFICATION: Refer to Section 16195 for requirements.

END OF SECTION 16140

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SECTION 16155 - MOTOR STARTERS

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK:

A. Types of motor starters in this section includes:

1. AC Fraction Horsepower Manual Starters
2. AC Line Voltage Manual Starters
3. AC Non-Reversing Magnetic Starters
4. AC Combination Non-Reversing Magnetic Starters

1.2. QUALITY ASSURANCE:

A. Comply with NEC and NEMA. Provide UL-listing and label.

1.3. SUBMITTALS:

A. PRODUCT DATA: Submit manufacturer's data.

B. SHOP DRAWINGS: Submit dimensioned drawings.

C. MOTOR VOLTAGE/CURRENT REPORT: After installation is complete, measure voltage of each phase of each motor.

PART 2 - PRODUCTS

2.1. MANUFACTURER: As specified.

2.2. MAINTENANCE STOCK, FUSES: Furnish spare fuses.

2.3. MOTOR STARTERS:

A. GENERAL: Provide motor starters and ancillary components; of types, sizes, ratings and electrical characteristics indicated which comply with manufacturer's standard materials.

B. THERMAL OVERLOAD UNITS: Provide thermal overload units, sized to actual running full load current.

C. AC FRACTIONAL HP MANUAL STARTERS (EQUAL TO SQUARE D CLASS 2510):

D. AC LINE VOLTAGE MANUAL STARTERS (EQUAL TO SQUARE D CLASS 2510):

E. AC COMBINATION NON-REVERSING MAGNETIC STARTERS (EQUAL TO SQUARE D CLASS 8539):

F. AC COMBINATION NON-REVERSING MAGNETIC STARTERS (EQUAL TO SQUARE D CLASS 8538):

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PART 3 - EXECUTION

3.1. INSTALLATION OF MOTOR STARTERS:

A. Comply with manufacturer's written instructions, recognized industry practices.

3.2. POWER FACTOR CORRECTION:

A. Provide individual capacitors for each motor rated 10HP or more selected to improve power factor to a minimum of 95%. Connect at motor terminals.

3.3. ADJUST AND CLEAN:

A. Inspect operating mechanisms. Adjust units.

3.4. FIELD QUALITY CONTROL:

A. Energize and demonstrate functioning.

3.5. ELECTRICAL IDENTIFICATION: Refer to Section 16195 for requirements.

END OF SECTION 16155

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SECTION 16156 - VARIABLE FREQUENCY DRIVES

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK:

A. Extent of variable frequency drive (VFD) work as shown by drawings, schedules and shown herein. Work includes complete installation, electrical connections, testing, and commissioning.

1.2 QUALITY ASSURANCE:

A. Comply with NEC, NEMA and IEEE. Comply with applicable requirements of UL 508, "Power Conversion Equipment".

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. GENERAL: Subject to compliance with requirements, provide products by Mitsibushi.

2.2 GENERAL:

A. Provide pulse width modulated variable frequency A.C. drives and ancillary components; of types, sizes, ratings and electrical characteristics indicated which comply with manufacturer's standard materials, design and construction in accordance with published information and as required for a complete installation.

2.3 VARIABLE FREQUENCY DRIVE SYSTEM:

A. The variable frequency AC drive shall convert 3 phase, 60 Hertz input power to an adjustable AC frequency and voltage for controlling the speed of AC squirrel cage motors. The rectifier section (converter) shall employ a diode or fully gated bridge to develop a constant DC bus voltage. Variable voltage rectifiers utilizing partially gated SCR's are unacceptable. The DC bus shall utilize filter capacitors and DC link inductors to minimize generated harmonics. The PWM inverter control scheme shall produce an output wave form which closely approximates actual sine wave current.

PART 3 – EXECUTION

3.1 INSTALLATION OF VARIABLE FREQUENCY DRIVES:

A. Install variable frequency drives as shown, in accordance with manufacturer's written instructions, applicable requirements of NEC, NEMA standards, and NECA's "Standards of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.

3.2 START-UP SERVICES:

A. The supplier of the AC drive described herein, shall provide field start-up service by an

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authorized factory trained service representative. The factory representative shall be trained in the maintenance and troubleshooting of the equipment as shown herein. Start-up service shall include system check-out, start-up and system run, and harmonic testing.

3.3 ELECTRICAL IDENTIFICATION: Refer to Section 16195 for requirements.

END OF SECTION 16156

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SECTION 16160 - PANELBOARDS

PART 1– GENERAL

1.1. DESCRIPTION OF WORK:

A. Types of panelboards and enclosures in this section include lighting and appliance panelboards.

1.2. QUALITY ASSURANCE:

A. Provide UL listing. Comply with NEC and NEMA Stds. Pub No. 250, and Pub No. 1.

1.3. SUBMITTALS:

A. PRODUCT DATA: Submit manufacturer data.

B. SHOP DRAWINGS: Submit dimensioned drawings of panelboards and enclosures.

PART 2 - PRODUCTS

2.1. ACCEPTABLE MANUFACTURERS: As specified.

2.2. PANELBOARDS:

A. POWER DISTRIBUTION PANELBOARDS: Dead-front safety type. Equip with copper bus bars, full-sized neutral bus and ground bus.

B. LIGHTING AND APPLIANCE PANELBOARDS: Dead-front safety. Provide bolt-on thermal magnetic type branch breakers. Equip with copper bus bars, full-sized neutral bus, and ground bus.

PART 3 - EXECUTION

3.1. INSTALLATION OF PANELBOARDS:

A. GENERAL: Install in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation".

3.2. ELECTRICAL IDENTIFICATION: Refer to Section 16195 for requirements.

END OF SECTION 16160

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SECTION 16170 - MOTOR AND CIRCUIT DISCONNECTS

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK:

A. Complete installation and electrical connections.

1.2. QUALITY ASSURANCE:

A. Comply with NEMA Standards and NEC. Provide UL listing.

1.3. SUBMITTALS:

A. PRODUCT DATA: Submit manufacturer's data including specifications, installation and general recommendations.

B. SHOP DRAWINGS: Submit dimensioned drawings of switches which have rating of 100 amperes and larger.

PART 2 - PRODUCTS

2.1. ACCEPTABLE MANUFACTURERS:

A. MANUFACTURER: As specified.

2.2. FABRICATED SWITCHES:

A. GENERAL: Provide:

1. General duty switches on 240 Volt rated circuits.
2. Heavy duty switches on 480 volt rated circuits.
3. HP rated switches on all motor circuits.

B. Provide switches serving variable frequency drives and elevators with auxiliary power hydraulic unit with auxiliary contacts.

2.3. FUSES: Provide fuses for switches. Provide spare fuses.

PART 3 - EXECUTION

3.1. INSTALLATION OF MOTOR AND CIRCUIT DISCONNECT SWITCHES:

A. Install switches where indicated, complying with manufacturer's written instructions, requirements of NEC, NEMA, and NECA's "Standard of Installation" and in accordance with recognized industry practices.

B. Coordinate with electrical raceway and cable work.

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3.2. ELECTRICAL IDENTIFICATION: Refer to Section 16195 for requirements.

END OF SECTION 16170

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SECTION 16175 - SWITCHGEAR AND SWITCHBOARDS

PART 1 - GENERAL

1.1. RELATED DOCUMENTS:

A. AC Dead Front Switchboards (600V)

1.2. QUALITY ASSURANCE:

A. Comply with NEC, NEMA, ANSI and IEEE. Provide UL-listing and label.

1.3. SUBMITTALS:

A. PRODUCT DATA: Submit manufacturer's data.

B. SHOP DRAWINGS: Submit dimensioned drawings.

C. MAINTENANCE STOCK FUSES: Furnish stock fuses.

PART 2 - PRODUCTS

2.1. ACCEPTABLE MANUFACTURERS: As specified.

2.2. AC DEAD FRONT SWITCHBOARDS (600V):

A. Factory assembled, dead front, metal enclosed, group mounted, secondary power switch boards, of ratings and characteristics indicated; consisting of panel (vertical) units, and containing circuit breaker and fusible switch assemblies. Provide copper main bus.

PART 3 – EXECUTION

3.1. INSTALLATION OF SWITCHGEAR AND SWITCHBOARDS:

A. Comply with manufacturer's written instructions, and recognized industry practices.

3.2. ADJUST AND CLEAN:

A. Adjust operating mechanisms.

3.3. FIELD QUALITY CONTROL:

A. Test switchgear and switchboards for electrical continuity of circuits, and for short circuits.

END OF SECTION 16175

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SECTION 16176 - MEDIUM VOLTAGE SWITCHES AND SWITCHGEAR

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

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

B. Division-16 Basic Materials and Methods sections apply to work of this section except as otherwise indicated. See Section 16420 Service Entrance, for metering requirements.

1.2 DESCRIPTION OF WORK:

A. Extent of switches and switchgear is indicated by drawings and schedules.

B. Types of switches and switchgear in this section include the following:

1. Pad Mounted SF6/Vacuum Fault Interrupter Switchgear (15kV)

1.3 QUALITY ASSURANCE:

A. Comply with NEC as applicable to construction and installation of electrical switches and switchgear. Provide switches and switchgear which have been UL listed and labeled.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Subject to compliance with requirements, provide products of one of the following (for each type of switch or switchgear): As specified

2.2 EQUIPMENT SECTIONS AND COMPONENTS:

A. GENERAL: Except as otherwise indicated, provide switches and switchgear of types, sizes, characteristics, and ratings indicated, which comply with manufacturer's standard design, materials, components, and construction in accordance with published product information, and as required for a complete installation.

2.3 PAD MOUNTED SF6/VACUUM INTERRUPTER SWITCHGEAR (15kv):

A. Provide factory assembled, pad mounted, dead front, group-operated, sectionalizing switchgear with main rating sf 600 amperes, and tap ratings of 600 amps for each tap. Incorporate three phase, group-operated overcurrent protection on each tap utilizing a resettable vacuum fault interrupters and electronic tripping unit. Conform with ANSI C37.72 for pad mounted switchgear, and ANSI C37.60 for duty cycle requirements.

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PART 3 – EXECUTION

3.1 INSTALLATION OF SWITCHGEAR:

A. Install switches and switchgear where shown, in accordance with manufacturer's written instructions with recognized industry practices to ensure that switches and switchgear comply with requirements of NEMA and NEC standards, and applicable portions of NECA's "Standard of Installation".

B. Install all switchgear on 4" high concrete curb and bolt equipment to curb with 5/8" anchors at each corner and at intervals not to exceed 8 feet along perimeter. Install concrete wiring trench under switchgear; 12" deep, and 4" smaller in length and width than equipment base. Install grounding bushings on conduits penetrating trench.

3.2 FIELD QUALITY CONTROL:

A. Provide the services of a qualified factory-trained manufacturer’s representative to assist the Contractor in installation and start-up of each switchgear specified herein. The period of factory assistance shall consist of the number of days required to properly assemble, test, and commission the equipment but in no case shall the period of assistance be less than one day for each type of switchgear specified. The manufacturer’s representative shall provide technical direction and assistance to the contractor in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein. At the completion of start-up the manufacturer’s representative shall certify that equipment has been installed, adjusted, and tested in accordance with the manufacturer’s recommendations. Provide three copies of the manufacturer’s certification.

3.3 TRAINING:

A. Provide training sessions for up to three owner’s representatives at the jobsite location determined by the owner. Sessions shall be conducted by a manufacturer’s qualified representative. Train program shall include instruction on the assembly, circuit breakers, protective devices (including complete programming instructions), and other major components.

END OF SECTION 16176

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SECTION 16180 - OVERCURRENT PROTECTIVE DEVICES

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK:

A. Types of overcurrent protective devices include:

1. Molded case circuit breakers
2. Molded solid state circuit breakers
3. Fusible switches
4. Fuses

1.2. QUALITY ASSURANCE:

A. Comply with NEC NEMA and ANSI standards.

1.3. SUBMITTALS:

A. PRODUCT DATA: Submit manufacturer's data.

B. SHOP DRAWINGS: Submit layout drawings.

C. MAINTENANCE STOCK, FUSES: Furnish spare fuses.

PART 2 - PRODUCTS

2.1. MOLDED CASE CIRCUIT BREAKERS: Provide breakers with permanent thermal trip and adjustable instantaneous magnetic trip in each pole.

2.2. MOLDED CASE SOLID STATE CIRCUIT BREAKERS: Provide breakers of amperage voltage and RMS interrupting rating shown and with solid state trip mechanisms.

2.3. FUSIBLE SWITCHES: Provide fusible switch units with quick-break, quick break mechanisms, visible blades and dual horpsepower ratings. Equip with lockable handles. Provide with Class R rejection fuse clip kits.

2.4. GROUND FAULT PROTECTION: Provide on all overcurrent protective devices where phase to ground voltage is in excess of 150 volts and the overcurrent protection device is capable of being set at or over 1000 amps.

PART 3 - EXECUTION

3.1. INSTALLATION OF OVERCURRENT PROTECTIVE DEVICES:

A. Install in accordance with the manufacturer's instructions.

B. Comply with NEC and NEMA standards.

C. Set field-adjustable circuit breakers for trip settings as indicated.

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D. Field test all ground fault devices.

3.2. FIELD QUALITY CONTROL:

A. Test devices for continuity of circuitry and for short-circuits.

3.3. ELECTRICAL IDENTIFICATION: Refer to Section 16195 for requirements.

END OF SECTION 16180

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SECTION 16181 - TRANSFORMERS

PART 1– GENERAL

1.1. DESCRIPTION OF WORK:

A. Types of transformers include the following:

1. Liquid-Filled transformers
2. Dry-type transformer

1.2. QUALITY ASSURANCE:

A. Comply with NEC as applicable portions of NEMA Std. Pub. Nos. TR1 and TR27; and with ANSI/IEEE standards.

B. Comply with ANSI/UL 506. Provide Ul listing.

1.3. SUBMITTALS:

A. PRODUCT DATA: Submit manufacturer's data.

B. SHOP DRAWINGS: Submit dimensioned drawings.

PART 2 -PRODUCTS

2.1. ACCEPTABLE MANUFACTURERS: As specified.

2.2. OIL-FILLED DISTRIBUTION TRANSFORMERS: Factory-assembled, liquid-filled outdoor type tamper resistant, pad mounted distribution transformers where shown; of sizes, and characteristics, as indicated; 3-phase 60-hertz.

2.3. DRY TYPE TRANSFORMERS: Factory-assembled, general purpose, air-cooled, copper wound dry-type distribution transformers where shown; of sizes and characteristics indicated.

PART 3 - EXECUTION

3.1. INSTALLATION OF TRANSFORMERS:

A. Comply with manufacturer's instructions, requirements of NEC, NEMA and IEEE standards.

B. TESTING: Energize test.

END OF SECTION 16181

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SECTION 16183 - MOTOR CONTROL CENTERS

PART 1– GENERAL

1.1. DESCRIPTION OF WORK: As specified herein and indicated on drawings.

1.2. QUALITY ASSURANCE: Comply with NEMA, IEEE and UL.

1.3. SUBMITTALS: PRODUCT DATA: Submit manufacturer's data.

PART 2 – PRODUCTS

2.1. MOTOR CONTROL CENTERS AND COMPONENTS

A. GENERAL: Provide NEMA Class I, Type B motor control centers of sizes, ratings, and characteristics indicated.

B. BUS SYSTEM: Provide 3 phase, 4 wire system unless indicated otherwise. Construct bus bars of silver plated copper.

C. STARTER UNITS: See Section 16155 MOTOR STARTERS.

PART 3 – EXECUTION

3.1. INSTALLATION OF MOTOR CONTROL CENTERS: Comply with equipment manufacturer's instructions.

3.2. ADJUST AND CLEAN: Adjust operating mechanisms for free mechanical movement.

3.3. FIELD QUALITY CONTROL: Energize motor control center circuitry and demonstrate capability and compliance with requirements. Correct malfunctioning units at site.

3.4. ELECTRICAL IDENTIFICATION: Refer to Section 16195 for requirements.

END OF SECTION 16183

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SECTION 16184 - POWER FACTOR CORRECTION

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

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

B. Division-16 Basic Materials and Methods sections apply to work specified in this section.

1.2 DESCRIPTION OF WORK:

A. Extent of power factor correction work is indicated by drawings and schedules. Work includes complete installation and electrical connections.

B. Types of power factor correction equipment in this section include the following:

1. Corrective capacitors

1.3 QUALITY ASSURANCE:

A. Comply with NEC as applicable to location and installation of power factor correction capacitors and ancillary equipment. Comply with requirements for ANSI/NEMA Std. Pub. No. ICS 2 pertaining to power factor correction capacitors. Comply with UL 810; "Capacitors". Provide power factor correction capacitors which are UL listed and labeled.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS: AS SPECIFIED

2.2 POWER FACTOR CORRECTION CAPACITORS:

A. GENERAL: Provide power factor correction capacitors and ancillary components; complying with manufacturer's standard materials, design and construction in accordance with published product information, and as required for a complete installation and as herein specified.

B. MOUNTING: Mount capacitors in motor control centers or adjacent to motors as indicated. Provide all necessary bus work, connectors, frames, racks, etc., necessary for properly installed and secured capacitor.

PART 3 - EXECUTION

3.1 INSTALLATION OF POWER FACTOR CORRECTION CAPACITORS:

A. Install power factor correction capacitors as indicated, in accordance with the manufacturer's written instructions and with recognized industry practices to ensure that capacitors comply with requirements.

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3.2 GROUNDING:

A. Provide tight equipment grounding connections for capacitors.

END OF SECTION 16184

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SECTION 16185 - PROTECTIVE DEVICE STUDY

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary conditions and Division 1 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK:

A. Protective device studies in this section include the following:

1. Fault current protective device and equipment evaluation
2. Protective device coordination study
3. Arc-flash hazard analysis and study

1.3 QUALITY ASSURANCE:

A. Provide protective device studies performed by qualified engineers of the equipment manufacturer or an approved consultant. Studies must bear the professional engineer's stamp of the engineer in responsible charge of the protective device studies. Perform all work in accordance with latest IEEE and ANSI standards.

PART 2 – STUDIES

2.1 FAULT CURRENT PROTECTIVE DEVICE & EQUIPMENT EVALUATION

A. Perform fault current analysis with the aid of a computer and appropriate software. Include as input data the maximum available short circuit contribution, resistance and reactance components of the branch impedances, the X/R ratios, base quantities selected, and other source impedances.

2.2 ANALYSIS/REPORT

A. Include the following in the report.

1. Description, purpose, basis and scope of the study and a single line diagram of that portion of the power system which is included within the scope of the study.
2. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties and commentary regarding same. Include formulas and description of methods used.
3. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings, fuse selection, and commentary regarding same.
4. Fault current calculations including a definition of terms and guide for interpretation of computer printout.
5. Recommended size for power fuses and recommended settings for ground fault relays and for all adjustable trip relays, circuit breakers, etc.

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2.3 ARC-FLASH HAZARD ANALYSIS AND STUDY

A. A perform the analysis and study in accordance with IEEE 1584.

2.4 PROTECTIVE DEVICE TESTING, CALIBRATION AND ADJUSTMENT

A. Provide the services of a qualified field engineer employed by the equipment manufacturer, and necessary tools and equipment to test, calibrate and adjust the protective relays, ground fault relays and circuit breaker trip devices as recommended in the Protective Device Study.

END OF SECTION 16185

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SECTION 16195 - ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.1 DESCRIPTION OF WORK:

A. Types of identification includes identification of electrical materials, equipment and installations:

1. Buried electrical line warnings.
2. Identification labels for raceways, cables and conductors.
3. Operational instruction signs.
4. Warning and caution signs.
5. Equipment label and signs.
6. Arc-Flash hazard labels

1.2 QUALITY ASSURANCE

A. Electrical Component Standard: Components and installation shall comply with NFPA 70 “National Electrical Code”

1.3 SUBMITTALS:

A. PRODUCT DATA: Submit manufacturer’s data on each type of electrical identification products.

PART 2 – PRODUCTS

2.1 ELECTRICAL IDENTIFICATION PRODUCTS

A. Color Adhesive Marking Tape for Raceways, Wires and Cables:

1. Self-adhesive vinyl tape not less than 3 mills thick by 1” to 2” in width.

B. Underground Line Marking Tape:

1. Permanent, bright colored, continuous-printed, plastic tape compounded for direct-burial service not less than 6” wide by 4 mills thick
2. Printed legend indicative of general type of underground line below.

C. Wire/Cable Designation Tape Markers:

1. Vinyl or vinyl-cloth, self-adhesive, wraparound, cable/conductor markers with pre-printed numbers and letters.

D. Brass or Aluminum Tags:

1. Metal tags with stamped legend, punched for fastener.
2. Dimensions: 2” X 2” 19 gage.

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E. Engraved, Plastic Laminated Labels, Signs and Instruction Plates:

1. Engraving stock melamine plastic laminate, 1/16” minimum thickness for signs up to 20” sq.“, or 8” in length; 1/8 “ thick for larger sizes. Engraved legend in ¼” high white letters on black face and punched for mechanical fasteners.

F. Baked Enamel Warning and Caution Signs for Interior Use:

1. Preprinted aluminum signs, punched for fasteners, with colors legend and size appropriate to location.

G. Fasteners for Plastic-Laminated and Metal Signs:

1. Self-tapping stainless steel screws or # 10/32 stainless steel machine screws with nuts, flat and lock washers.

H. Cable Ties:

1. Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18” minimum width, 50-lb. Minimum tensile strength, and suitable for a temperature range from minus 50° F. to 350° F. Provide ties for specified colors when used for color coding.

I. Arc-Flash Hazard Labels

1. ANSI Z535.4 safety label
2. Information contained: Arc-flash boundary; voltage; flash hazard category; incident energy (arc rating); and check boxes for the required personal protective equipment (PPE).

J. Identify Junction, Pull and Connection Boxes:

1. Label and paint the covers of the systems junction boxes as follows:

SYSTEM	COLOR
Fire Alarm	Red
Sound/IC	Blue
Telephone	Yellow
Data	Green
MATV	Black
Security	Orange

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install identification devices in accordance with manufacturer’s written instructions and requirements of NEC.

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B. Mark each device box (for each type of wiring device) with a permanent ink felt tip marker, indicating the circuit to which the device is connected: Example; “CKT A-1”

C. Label circuit breaker feeding fire alarm panel “Fire Alarm Circuit”. Using plastic laminate label, white lettering on a red background.

END OF SECTION 16195

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SECTION 16400 - MANHOLES

PART 1 – GENERAL

1.1 The General Conditions. Supplementary General Conditions, Alternates and Addenda, applicable drawings and the technical specifications herein shall apply to all work under this Section.

1.2 DESCRIPTION OF WORK:

A. Furnish all labor, materials, equipment, appliances and perform all operations in connection with the installation of all new manholes and alterations to existing manholes complete in strict accordance with this section of the specifications and the applicable drawings and subject to the terms and conditions of the contract.

PART 2 - CONSTRUCTION:

2.1 MANHOLES

A. Manholes shall be constructed in accordance with the details shown or referred to on the drawings. Top, walls, and bottom shall be composed of reinforced concrete. Concrete, forms, mixing, pouring, and reinforcing bars shall conform to the requirements of Division 3 - CONCRETE, of these specification. Manholes shall be suitable for H2O highway loading. Minimum size opening of roof shall be as detailed.

2.2 BUILT-IN HARDWARE ITEMS:

A. Frames and covers shall be made of gray cast iron. A machine finished seat shall be provided to ensure a perfect joint between the frame and the cover. Frames and covers as detailed on the drawings are those as manufactured by COMCO Foundry, Inc. of Commerce City, Colorado. Covers shall have "ELECTRIC" or "COMMUNICATIONS", as applicable, cast in top for identification as detailed. Covers shall be equipped with lifting handles.

B. Three horizontal runs of Super Strut series #C300 shall be embedded in each wall of manhole as detailed. Each strip shall have waxed cardboard filler to keep concrete from entering slot. Cable pulling irons and sump frame and grating shall be as detailed on drawings.

2.3 SUMP:

A. Manholes shall be provided with rock sump as detailed. Slope floor to sump as indicated.

2.4 GROUND ROD:

A. This contractor shall furnish and install in each manhole, at a convenient point close to the wall as shown, 3/4-inch X 10'-0" long copper or copper-clad steel ground rod. Rods shall be driven into the earth not less than eight feet before the manhole floor is poured. The rod shall extend approximately 6-inches above the manhole floor. Install in accordance with Article 250 of the National Electrical Code. Minimum size bonding conductor shall be #2 bare copper.

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2.5 PORTABLE MANHOLE LADDERS:

A. Each manhole shall be equipped with a portable hot dipped galvanized steel manhole ladder, 12 feet long. Rungs shall be spaced 12-inches on centers and shall be corrugated, knurled, dimpled, coated with skid-resistant material or otherwise treated to minimize the possibility of slipping. Minimum width between side rails shall be 12-inches. Side rails shall be minimum 1-1/2 X 9/16 X 3/16 inches channel size. Rungs shall be minimum 5/8 inches diameter. Manufacturer shall certify that ladder complies to all OSHA requirements for a portable metal ladder.

END OF SECTION 16400

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SECTION 16420 - SERVICE ENTRANCE

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK:

A. Extent of service-entrance work is indicated by drawings and schedules.

B. Provide labor and materials as required to accomplish power company metering in accordance with power company standards and requirements.

1.2. QUALITY ASSURANCE:

A. Comply with NEC and NEMA standards.

1.3. SUBMITTALS:

A. PRODUCT DATA: Submit manufacturer's data.

B. SHOP DRAWINGS: Submit dimensioned layouts.

C. MAINTENANCE STOCK, FUSES: Furnish spare fuses.

PART 2 – PRODUCTS

2.1. SERVICE - ENTRANCE EQUIPMENT:

A. GENERAL: Provide service-entrance equipment and accessories, of types, sizes, ratings and electrical characteristics indicated.

B. Provide each service entrance switchboard with surge protective device.

2.2. OVERCURRENT PROTECTIVE DEVICES:

A. METERING: Provide Square D power logic circuit monitor, class 3020, model CM-3250, integrally mounted in service equipment.

PART 3 – EXECUTION

3.1. INSTALLATION OF SERVICE-ENTRANCE EQUIPMENT:

A. Comply with manufacturer's written instructions, and with recognized industry practices.

3.2. GROUNDING:

A. Provide system and equipment grounding.

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3.3. ADJUST AND CLEAN:

A. Adjust operating mechanisms.

3.4. FIELD QUALITY CONTROL:

A. Test service-entrance equipment and electrical circuitry, energize circuitry and demonstrate capability and compliance with requirements.

END OF SECTION 16420

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SECTION 16452 - GROUNDING

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK:

A. Types of grounding in this section include the following:

1. Underground Metal Water Piping
2. Metal Building Frames
3. Grounding Electrodes
4. Grounding Rods
5. Separately Derived Systems
6. Service Equipment
7. Enclosures
8. Systems
9. Equipment
10. Other items indicated on drawings

1.2. QUALITY ASSURANCE:

A. Comply with NEC, ANSI and IEEE requirements. Provide UL listing.

PART 2 – PRODUCTS

2.1. GROUNDING:

A. MATERIALS AND COMPONENTS:

1. GENERAL: Provide grounding system including cables, connectors, terminals, ground rods, bonding jumper braid, and accessories.

B. GROUND RODS AND PLATES:

1. GROUND RODS: Steel with copper welded exterior, 3/4" dia. x 10'.

PART 3 – EXECUTION

3.1. INSTALLATION OF GROUNDING SYSTEMS:

A. Comply with manufacturer and with recognized industry practices.

B. Provide grounding for the entire raceway, enclosure, equipment and device system.

END OF SECTION 16452

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SECTION 16510 - INTERIOR AND EXTERIOR BUILDING LIGHTING

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK:

A. Types of lighting fixtures in this section include the following:

1. High-Intensity-Discharge (HID)
2. Fluorescent
3. Incandescent
4. LED

1.2. QUALITY ASSURANCE:

A. Comply with NEC, NEMA and ANSI 132,1. Provide UL-listing.

1.3. SUBMITTALS:

A. PRODUCT DATA: Submit manufacturer's data.

B. SHOP DRAWINGS: Submit dimensioned drawings of lighting fixtures.

PART 2 - PRODUCTS

2.1. ACCEPTABLE MANUFACTURERS:

A. FLUORESCENT AND HID BALLASTS INCANDESCENT AND FLUORESCENT LAMPS HID LAMPS: As Specified.

2.2. INTERIOR AND EXTERIOR LIGHTING FIXTURES:

A. SUPPORT REQUIREMENTS: Provide pendant and stem hung fixtures with flexible ball joint hangers. Provide all detachable fixture parts, luminous ceiling accessories, louvers, diffusers, lenses, and reflectors with locking catches, screws, safety chain, or safety cable.

B. FLUORESCENT-LAMP BALLASTS: Provide Class P; sound-rated A, and with internal thermal protection. For interior fixtures, provide full light output energy conserving ballasts.

C. FLUORESCENT LAMPS: Equip interior fixtures with full light output, energy conserving lamps.

D. DIFFUSERS: 100 percent virgin acrylic compound; minimum thickness, .125 inches.

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PART 3 - EXECUTION

3.1. INSTALLATION OF LIGHTING FIXTURES

A. Install lighting fixtures in accordance with fixture manufacturer's instructions, applicable requirements of NEC.

B. Provide all necessary supports, brackets, and miscellaneous equipment for mounting of fixtures.

C. COORDINATION MEETINGS: Meet at least twice with the ceiling installer. Coordinate depth and location of all fixtures and duct work in all areas.

D. ADJUST AND CLEAN: Clean lighting fixtures of dirt and debris.

E. Protect installed fixtures from damage.

3.2. FIELD QUALITY CONTROL:

A. Demonstrate capability and compliance with requirements.

B. Replace lamps not working at Substantial Completion.

C. GROUNDING: Provide equipment grounding connections for each lighting fixture.

END OF SECTION 16510

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SECTION 16551 - EXTERIOR AREA LIGHTING

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK: Extent of area lighting is indicated by drawings.

1.2. QUALITY ASSURANCE: Comply with NEC, NEMA and ANSI/IES requirements. Provide UL listing.

1.3. SUBMITTALS: Product Data: Submit manufacturer's.

PART 2 - PRODUCTS:

2.1. MANUFACTURER: As specified.

2.2. FUSES: Provide spare fuses for each type and size used.

PART 3 - EXECUTION:

3.1. Install in accordance with manufacturer's written instructions, applicable requirements of NEC, NESC and NEMA.

3.2. Coordinate with other work interface installation of roadway and parking area lighting with other work.

3.3. Mount lighting units on concrete bases as indicated.

3.4. Provide Bussman HEB fuseholder with "breakaway" receptacles. Provide equipment grounding connections.

3.5. GROUNDING: Provide equipment grounding connections.

END OF SECTION 16551

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SECTION 16560 - LIGHTING CONTROL EQUIPMENT

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK:

A. Type of lighting control equipment specified in this section includes the following:

B. Building lighting control systems.

PART 2 -PRODUCTS

2.1. ACCEPTABLE MANUFACTURERS: As specified

2.2. LIGHTING CONTROL EQUIPMENT:

A. Building: Provide a low-voltage lighting control system to comply with ASHRAE. Provide relay panels.

B. Relay panels will be programmable. Interior lighting circuits will be programmed to respond to low voltage switch inputs for manual control, and by time-of-day for automatic control. Lighting circuits in public areas will be programmed to operate by a time-of-day work schedule. Exterior lighting will be programmed to operate by a combination of photosensor and time-of-day.

PART 3 - EXECUTION

3.1. INSTALLATION OF LIGHTING CONTROL EQUIPMENT:

A. Coordinate with other electrical work, including raceways, and electrical boxes and fittings, as necessary to interface installation of lighting control equipment work with other work. Contractor shall be on site as required, to adjust lighting control units for proper light levels as directed by engineer.

3.2. MANUFACTURER AUTHORIZED PERSONNEL TRAINING:

A. Building Operating Personnel Training: Train Owner's building personnel in procedures for starting-up, testing and operating lighting control system equipment.

END OF SECTION 16560

SECTION 16561 - OCCUPANCY SENSORS

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK:

A. The extent of occupancy sensor work is indicated by drawings.

B. Types of occupancy sensors in this section include the following:

1. Passive Infrared Wall Switch
2. Dual Technology Ceiling Sensor w/ Control Pack

1.2 QUALITY ASSURANCE:

A. Comply with NEC and NEMA standards as applicable to construction and installation of occupancy sensors. Provide occupancy sensors which have been UL listed and labeled.
B. All sensors shall be capable of operating normally with electronic ballasts, PL lamp systems, motor loads and any other passive infrared or microwave systems.

PART 2 - PRODUCTS

2.1 OCCUPANCY SENSORS:

A. PASSIVE INFRARED WALL SWITCH: Where units are indicated provide a sensor that meets the following minimum requirements:

1. Sensor shall utilize a dual element pyroelectric detector behind a lens to detect the motion of infrared energy emitted by the human.
2. Lens shall be of the multi-element type that divides the field of view into forty zones of detection.
3. Sensor shall fit a single gang switch box and utilize a decorator cover plate.
4. Sensor shall have a time-out delay, adjustable from 1 minute to 30 minutes.
5. Sensor shall have an Automatic/OFF switch on front of unit.
6. Sensor shall have a 170 degree field of view. Detection beam shall be horizontal.
7. Sensor shall be rated for 0 to 600 watts at 120VAC and 277VAC and adapt automatically to the operating voltage.

B. DUAL TECHNOLOGY CEILING SENSOR: Where units are indicated, provide a sensor that meets the following minimum requirements:

1. Sensor shall incorporate ultrasonic (microphonics) and infrared technologies in a single unit.
2. Sensor shall have automatic self-adjustment algorithm which adjusts timer and sensitivity settings to maximize performance and minimize energy usage.
3. Sensor shall have manual time-out adjustment from 8 minutes to 32 minutes and automatic time out from 8 minutes to 100 minutes.
4. Sensor’s microprocessor shall automatically reduce either PIR or ultrasonic sensitivity in response to false on condition.
5. Sensor microprocessor will automatically monitor PIR background threshold signal

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level and makes corresponding sensitivity adjustments automatically.

6. Infrared lens shall have 360 degree field of view. Two types of lens shall be available, standard and extra dense.

PART 3 – EXECUTION

3.1 INSTALLATION OF LIGHTING CONTROL EQUIPMENT:

A. Install occupancy lighting control system components and ancillary equipment as indicated, in accordance with equipment manufacturer's written instructions, and with recognized industry practices, to ensure that lighting control equipment complies with requirements.

3.2 MANUFACTURER AUTHORIZED PERSONNEL TRAINING:

A. Building Operating Personnel Training: Train Owner's building personnel in procedures for starting-up, testing and operating lighting control system equipment.

END OF SECTION 16561

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SECTION 16600 – SURGE PROTECTIVE DEVICES (SPD)

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK:

A. Extent of SPD work is indicated by drawings, schedules and specified herein. Work includes complete installation, electrical connections and testing.

1.2 QUALITY ASSURANCE:

A. Comply with NEC, NEMA and IEEE Standards as applicable to wiring methods, construction and installation of SPD devices. Comply with applicable requirements of ANSI/IEEE C62.11, C62.41, and C62.45; and UL 1449. Provide complete packaged units that have been listed and labeled by Underwriters Laboratory. UL surge ratings (UL 1449) must be permanently affixed to the SPD device.

PART 2 - PRODUCTS:

2.1 GENERAL:

A. Except as otherwise indicated, provide high energy transient voltage surge suppression devices, with high frequency line noise filtering. Provide types, sizes, ratings and electrical characteristics that comply with manufacturer's standard materials, design, and construction in accordance with published information and as required for a complete installation.

2.2 SPD SYSTEM DESCRIPTION:

A. Provide SPD devices that comply with the following:

1. Have a maximum continuous operating voltage not less than 125% of the nominal system operating voltage, and a frequency operating range of 47 to 63 hertz.
2. Provide protection modes of line-to-neutral (when neutral is present in the system), line-to-ground, and neutral-to-ground (when neutral is present).

B. Provide units consisting of engineered solid-state high-performance suppression and filtering modules consisting of arrays of nonlinear voltage dependent metal oxide varistors, selenium cells, and/or silicon avalanche diodes that optimally share surge currents in a seamless, low-stress manner assuring maximum performance.

2.3 UNITS INSTALLED AT LEVEL ONE LOCATIONS:

A. Where units are shown on the drawings installed at MDP (or required by other sections of the specification), provide a SPD, sine wave tracking, high frequency filtering device, which meets the following minimum requirements:

1. Minimum single impulse surge current rating:

a. Line to neutral (each individual phase): 160,000
b. Line to ground (each individual phase 160,000

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c. Neutral to ground: 100,000

2. UL 1449 suppressed voltage rating not exceeding:

a.

Voltage	L-N	L-G
120/208	400	400

3. Category C3 clamping voltage ANSI/IEEE C.62.41-1991(Reaffirmed 1995) (20KV-1.2/50 microsec., 10KA microsec.) Not exceeding:

a.

Voltage	L-N	L-G
120/208	625	625

2.4 UNITS INSTALLED AT LEVEL 2 LOCATIONS:

A. Where units are shown on the drawings (or required by other sections of the specification) at locations identified as "Level 2" locations, provide a SPD, sine wave tracking, high frequency filtering device at each of these locations, which meets the following minimum requirements:

1. Minimum single impulse surge current rating:

a. Line to neutral (each individual phase): 80,000
b. Line to ground (each individual phase): 80,000
c. Neutral to ground: 80,000

2. UL 1449 suppressed voltage rating (with fusible unit inserted) not exceeding:

a.

Voltage	L-N	L-G
120/208	400	400
277/480	800	800

PART 3 – INSTALLATION

A. Install SPD devices as shown in accordance with manufacturer's recommendations and as necessary to meet requirements. Install with conductors of minimum length practicable, but in no case exceeding 30" in length; minimum conductor size - #8 AWG copper.

END OF SECTION 16600

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SECTION 16610 - EMERGENCY ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK: Types include the following:

A. Automatic Transfer Switches
B. Emergency Generators (Diesel)
C. Exhaust and Fuel Systems

1.2. QUALITY ASSURANCE: Comply with NEC UL 924, and UL 1008. Provide system components which are UL-listed and labeled.

1.3. SUBMITTALS:

A. PRODUCT DATA: Submit manufacturer's data.

B. SHOP DRAWINGS: Submit dimensioned drawings of emergency system components; indicate spatial relationship to associated equipment.

C. Provide components suitable for:

1. Altitude: 4800 feet above sea level

2. Maximum ambient temperature: 50 degrees C.

3. Minimum ambient temperature: 9 degrees C.

D. AUTOMATIC TRANSFER SWITCHES: OT II AUTOMATIC TRANSFER SWITCH

1. Contactor type switches with:

a. Adjustable voltage sensors to start and transfer engine.

b. Time delay for transfer and retransfer.

c. Clock exerciser.

E. RATING AND PERFORMANCE: Continuous duty; NEMA 1 enclosure, 4 pole, transfer switch and bypass/isolation switches shall be in one enclosure.

1.4. MANUFACTURERS: Generac, Cummins

1.5. ENGINE GENERATOR UNITS: 60 hertz alternating-current standby-diesel engine-driven generator.

1.6. ENGINE INSTRUMENTS:

A. Oil Pressure Gauge
B. Coolant Temperature Gauge

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C. Battery Charge Rate Ammeter

1.7. EXHAUST SYSTEM: Critical type exhaust silencer.

1.8. MOUNTING: Vibration isolators between the electric set and base.

1.9. FUEL SYSTEM: Primary and secondary fuel filters with replaceable elements, and an engine driven fuel pump. Provide fuel system piping. Provide tank mounted between the rails of the generator skid, sized for 12 hours of operation at full load.

1.10. ELECTRIC ALTERNATOR: Direct connected, engine driven, single bearing, synchronous type alternator.

PART 2 - EXECUTION

2.1. INSTALLATION OF ENGINE-GENERATOR SYSTEMS: Install equipment as indicated, in accordance with the equipment manufacturer's instructions, and with recognized industry practices.

2.2. GROUNDING: Provide equipment grounding.

2.3. TESTING: Demonstrate standby capability.

2.4. ELECTRICAL IDENTIFICATION: Refer to Section 16195 for requirements.

END OF SECTION 16610

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SECTION 16721 - FIRE ALARM AND DETECTION SYSTEMS

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK:

A. Comply with NEC. Provide UL-listing

1.2. SUBMITALS:

A. PRODUCT DATA: Submit manufacturer's data; typical riser and complete wiring diagrams.

B. SHOP DRAWINGS: Provide shop drawings showing equipment/device locations and connecting wiring

PART 2 - PRODUCTS

2.1. ACCEPTABLE MANUFACTURERS:

A. MANUFACTURERS: Simplex (to tie to campus networked system)

2.2. FIRE ALARM AND DETECTION SYSTEMS:

A. SYSTEM TYPE: (Addressable)

2.3. SYSTEM OPERATION:

A. Annunciate alarms.
B. Deactivate air supply and return fan units.
C. Release magnetic door holders.
D. Damper and shut down supervision.
E. Sprinkler Supervision. Provide a signal initiating and supervisory circuit to each sprinkler riser and subdivision.
F. Initiate smoke control procedures.
G. Remote Signal Transmission. Provide transmitter. Transmit alarm and trouble signal to campus.

2.4. EQUIPMENT:

A. FIRE CONTROL PANEL: Provide solid-state, modular design with integral static protection.

B. SIGNALING MODULES: As required.

C. MUNICIPAL TRIP: Distinct, separate municipal trip circuit and municipal trip disconnect switch.

D. BATTERIES: (Nickel Cadmium, Gel Cell) located in central control unit.

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E. MANUAL FIRE ALARM STATION: Double action, break glass.

F. TEMPERATURE DETECTORS, COMBINATION FIXED TEMPERATURE/RATE OF RISE: Automatically resetting.

G. IONIZATION SMOKE DETECTORS: Resetable from central control panel.

H. GATE VALVE SUPERVISORY SWITCHES:

I. POST INDICATOR VALVE SWITCH:

J. WATER FLOW SWITCHES:

K. MAGNETIC DOOR HOLDERS: Minimum hold force of 156 lb. at 85% of rated voltage.

L. AUDIOVISUAL ALARM HORNS: Capable of 95 db sound level at 10 feet.

M. ALARM HORNS: Capable of 87 db sound level at 10 feet.

N. DUCT IONIZATION DETECTORS:

PART 3- EXECUTION

3.1. INSTALLATION OF FIRE ALARM AND DETECTION SYSTEMS:

A. Install as indicated, in accordance with equipment manufacturer's written instructions.

B. Wire initiating circuits are four wire, Class A circuits with separate conduit runs for outgoing and return portions of the Class A loop.

C. Install all wiring in raceway. Minimum raceway size, 3/4"; minimum conductor size, #14 AWG.

3.2. TESTING:

A. Provide factory trained representative to perform complete system testing.

3.3. ELECTRICAL IDENTIFICATION: Refer to Section 16195 for requirements.

END OF SECTION 16721

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SECTION 16741 - TELEPHONE/DATA SYSTEMS

PART 1 – GENERAL

1.1 SCOPE OF DOCUMENT:

A. The following are project specifications to which all cabling systems must adhere. These specifications apply to all installers (hereinafter referred to as “the Contractor”) for all sites, which require, standards-compliant structured cabling systems and shall be used for all the installation, testing, and acceptance of the information transport systems as described in the attached specifications. Prices quoted of the installation facilities shall be all-inclusive and represent a complete installation at such sites as prescribed in this specification and contract documents. The Contractor shall be solely responsible for all parts, labor, testing, acceptance and all other associated processes and physical apparatus necessary to turn-over a completed system fully warranted and operational for acceptance by the Customer. Final acceptance of the installation shall be in writing by the Architect and Engineer.

1.2 RELATED DOCUMENTS:

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

B. Division-16 Basic Materials and Methods sections apply to work specified in this section.

1.3 SCOPE OF WORK:

A. The extent of telephone/data system work is indicated by drawings and is hereby defined to include, but not be limited to racks, cabinets, patch panels, cables, raceway, outlet boxes, device plates, backboard, and grounding. Contractor is responsible for installation of all specified and unspecified necessary and miscellaneous items required for delivery of a complete and functional data cabling and device system.

B. Contractor shall provide complete cable and outlet system as indicated on the drawings and described herein. Work shall include all associated infrastructure transmission components and support appliances including, but not be limited to cable, jacks, terminal blocks, racks, cabinets, wire management, labeling, transient voltage surge suppression, patch cords, and all terminations as specified herein.

C. Contractor shall provide system testing as described herein using up-to-date and industry accepted Level IV test equipment appropriate to the types of links being tested and in accordance with the latest edition of IEC 61935-1. All testers used shall be factory calibrated within one year of use with references set daily prior to testing.

D. Contractor shall provide all labor, materials, tools and equipment required for the complete installation of work called for in the Construction Documents.

E. Contractor shall provide conduit from telecommunications outlet/connector to cable tray.

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1.4 CONTRACTOR QUALIFICATIONS

A. The contractor shall be fully conversant and capable in the cabling of low voltage applications such as, but not limited to voice and data network systems. The Contractor shall at a minimum possess the following qualifications:

1. Must have at a minimum (1) RCDD certified individual on-staff.
2. BICSI Certified Installers or equivalent.
3. Possess those licenses/permits required to perform telecommunications installations in the specified jurisdiction.
4. Have a minimum of 5 years in the communications structured cabling business and be able to provide three owner references for the type of installation described in this specification for projects within the last 18 months.
5. Personnel trained and certified in fiber optic cabling, splicing, termination and testing techniques. Personnel must have experience using a light meter and OTDR and shall be factory certified by the manufacturer of the products being installed.
6. Personnel trained in the installation of pathways and support for housing horizontal and backbone cabling.
7. Personnel knowledgeable in local, state, province and national codes, and regulations. All work shall comply with the latest revision of the codes or regulations. When conflict exists between local or national codes or regulations, the most stringent codes or regulations shall be followed.
8. Be factory certified by the manufacturer used in installation of all transmission components of all copper and fiber links and able to provide the manufacturer warranty.

1.5 APPLICABLE CODES AND STANDARDS

A. Contractor is responsible for compliance with all applicable portions of the NEC code as to type of products used and installation of components. All materials used shall be products and materials which have been UL-listed and labeled. All installed products shall comply with applicable NEMA standards for low loss extended frequency cable.

B. In addition installation shall adhere to the following Standards:

1. ANSI/TIA-568-C.0 - Generic Telecommunications Cabling for Customer Premises, or most recent edition at the time of installation
2. ANSI/TIA-568-C.1 – Commercial Building Telecommunications Cabling Standards, or most recent edition at the time of installation
3. ANSI/TIA-568-C.2 - Balance Twisted Pair Communications and Components Standards, or most recent edition at the time of installation
4. ANSI/TIA –942 -Telecommunications Infrastructure for Data Centers, or most recent edition at the time of installation
5. TIA-569-B - Commercial Building Standard for Telecom Pathways and Spaces, or most recent edition at the time of installation
6. ANSI/TIA-606-A – Administration Standard for the Telecommunications Infrastructure of Commercial Buildings, or most recent edition at the time of installation
7. ANSI-J-STD-607-A - Commercial Building Grounding/Bonding Requirements, or most recent edition at the time of installation
8. ANSI/TIA 1152 – Testing of Copper Links

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9. BICSI Telecommunications Distribution Methods Manual, 12th edition or most recent edition at the time of installation.
10. TIA 758-A - Customer owned Outside Plant Telecommunications Infrastructure Standard (2004), including all applicable addenda and the most recent revision at the time of installation.
11. BICSI Information Transport Systems Installation Manual - 5th edition or most recent edition at the time of installation.
12. ANSI/NFPA-70 - 2008 National Electrical Code, revision, or most recent revision at the time of installation.
13. ANSI/IEEE C-2 - 2007 National Electrical Safety Code or most recent revision at the time of installation.
14. OSHA Standards and Regulations All applicable
15. Local Codes and Standards All applicable

C. Note: Anywhere cabling standards conflict with electrical or safety codes, Contractor shall defer to NEC and any applicable local codes or ordinances, or default to the most stringent requirements listed by either. Knowledge and execution of applicable codes is the sole responsibility of the Installer. Any code violations shall be remedied at the Contractor's expense.

1.6 ACCEPTABLE MANUFACTURERS:

A. General:

1. The below manufacturers are acceptable throughout the usage of this specification.

B. Manufacturers:

1. Commscope Systimax Solution

1.7 SUBMITTALS:

A. Provide submittals for all racks/cabinets; patch panels, devices, cabling, firestopping solutions, tray, grounding equipment, and miscellaneous equipment to be used on project. Where multiple part numbers are listed on a datasheet/cutsheet, highlight or circle applicable part.

B. Provide submittals showing complete racking layout in plan and elevation view to scale.

C. For any unspecified components, Contractor shall submit manufacturer's data and installation details for all devices, plates, cables, termination blocks, patch cords, line suppression blocks, wire management, labels, and similar equipment.

D. Provide color samples of all available standard color faceplates to architect.

PART 2 - PRODUCTS

2.1 GENERAL:

A. All products shall be in new condition and UL listed.

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B. Provide complete raceway, outlet boxes and miscellaneous items. All conduit utilized shall be EMT grade.

C. Provide 4-11/16” x 2-1/8" deep square outlet box at each outlet location with single gang plaster or tile ring. Provide wall board adapters as necessary.

D. Communication grounding and bonding shall be constructed and installed to meet or exceed the requirements of the National Electrical Code (NEC), IEC 1000-5-2 and ANSI/J-STD--607-A throughout the entire grounding system.

E. All termination hardware shall be rated to meet Category 6 specifications.

2.2 ENTRANCE FACILITY (EF) / EQUIPMENT ROOM (ER) / TELECOMMUNICATIONS ROOM (TR)

A. General:

1. Contractor shall be responsible for the adequate and appropriate design of all racking systems, paying particular attention to sizing of all cable management troughs and supports both horizontal and vertical installation of patch panels and wire management into rack.
2. Provide line surge suppressors at main telephone board in ER for all incoming phone lines if not provided by service provider. Provide ground connection to TMGB.

2.3 CABLING DISTRIBUTION SYSTEMS AND MISCELLANEOUS EQUIPMENT

A. Cabling Distribution System

1. Approved Cabling Distribution System Manufacturers:
   a. CommScope Systimax Solution

2. General:
   i. Provide plenum rated cable if required, cabling must be appropriate for the environment in which it is installed.
   ii. Contractor shall be responsible for sizing all pathways such that newly installed cable represents not more than a 35% fill as per manufacturer’s directions. Overfilled pathways are the sole responsibility of the Contractor who shall remove and reinstall at Contractors expense.
3. Backbone Cabling Distribution System – Optical Fiber
   a. General:
      i. Provide fiber jumpers of appropriate length and cable type for each optical switch port to go back to optical fiber adapter patch panel. Provide OFNR or OFNP as required.
      ii. Provide 900μm tight-buffered optical fiber cable.
   b. Connectors:
      i. Provide LC-Duplex Connectors.
      ii. LC-Duplex Connectors shall have a cleave/polish termination process which incorporates use of a reliable anaerobic adhesive which has a high resistance to environmental extremes.
      iii. Polish type connectors are preferred, Cam type is not acceptable.

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iv. Similar to Panduit FLCDM900BLY for multimode optical fiber.

c. Multi-Mode Fiber Optic Cable (OM3)

i. All multimode optical fiber cabling shall be 50μm/125μm micron laser-optimized cable, designation OM3.

ii. Provide two strands between each EF/ER, ER/TR, and TR/TE for every 48-port patch panel, however minimum cable size shall be 6-strand. Provide a minimum fiber strand count between areas listed above of 6-strands. Provide 25% extra fiber pair strands if more than 6-strands are required. See riser diagram for additional information.

4. Horizontal Cabling Distribution System – Balanced Twisted Pair

a. General:

i. Provide and install appropriate number of Category 6 patch cables for all terminated data drops, between switches, etc. so that building-wide networking will be operational once all installation is complete.

b. 4-Pair 100Ω Balanced Twisted Pair Cable Including Patch Cables:

i. Provide Category 6 UTP (250MHz) Patch Cables for each EF/ER/TR/TE and telecommunications outlet connections, for every terminated drop in the EF/ER/TR/TE, but sized according to application, not to exceed TIA recommendations.

ii. Follows:

1. Voice: Yellow
2. Data: Blue

5. Telecommunications Outlets/Connectors (See Plans For Locations):

a. Sloped Faceplates:

i. Provide modular type information outlets with sloped telephone jack or data outlet. Provide single gang faceplate kits to allow up to four data or voice jacks as shown on plans. Provide faceplate kits for wall outlets in colors and materials that match power wiring device plates. Provide faceplate kits that allow labeling schemes described herein. Provide device jacks in color schemes as selected by the architect. Accept STP, UTP, fiber optic or audio/video modules as an option.

ii. Color: Match wiring device plates.

b. 8P8C Connector:

i. Provide Category 6/Class E eight-position eight-contact (8P8C) jack, The white termination cap shall be color coded for T568A and T568B wiring schemes.

ii. Be a Category 6/Class E eight-position jack module that terminates on unshielded twisted 4 pair, 22 – 26 AWG, 100 ohm cable utilizing a 110 punch down solution. Terminate using a forward motion to maintain cable pair geometry, minimize untwist while minimizing stress on critical circuit-board components.

iii. Color: Off-White

PART 3 – EXECUTION

3.1 GENERAL

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A. Prior to pathway rough-in, low voltage contractor shall meet with electrical contractor to review pathway installation requirements.

B. Pathway Requirements:

1. General:
   a. All pathways shall be designed, constructed, grounded and installed in accordance with all recommendations delineated within TIA 569-B and Standard TIA 942.
   b. Prior to placing any cable pathways or cable, the contractor shall survey the site to determine job conditions will not impose any obstructions that would interfere with the safe and satisfactory placement of the cables. Arrangements to remove any major obstructions not identified on plans need to be determined at that time with the Engineer.
2. Cable Tray Within EF/ER/TR:
   i. Wrapped around room (wall support is acceptable)
   ii. Along equipment rows leading to cross-connects.
   iii. Ground tray to TGB or TMGB (whichever is closer) utilizing #6CU bare wire.
3. Racks / Cabinets:
   a. Racks shall be securely attached to the concrete floor using minimum 3/8" hardware or as required by local codes.
   b. Racks shall be placed with a 36-inch (minimum) clearance from the walls on all sides of the rack. When mounted in a row, maintain a minimum of 36 inches from the wall behind and in front of the row of racks and from the wall at each end of the row.
4. Conduits:
   a. Provide a quantity of one 1" conduit from each telecommunications box to nearest cable tray, or EF/ER/TR/TE. Flexible conduit is not acceptable as cable tends to creep, shift, or have sheath damage.
   b. Provide a quantity of (3) 4" conduits as a minimum between TRs, regardless of whether noted on the drawings.
   c. Provide a quantity of (4) 4" conduits as a minimum between the EF/ER and TR, regardless of whether noted on the drawings. Note this only applies if they are separate rooms.
   d. Provide (4) 4" conduits as a minimum between the EF and ER, regardless of whether noted on the drawings. Note this only applies if they are separate rooms.
   e. Achieve the best direct route parallel with building lines with no single bend greater than 90 degrees or an aggregate of bends in excess of 180 degrees between pull points or pull boxes.
   f. Conduit runs shall not have continuous sections longer than 100 feet without a pull box and may only be filled to 35% capacity.
   g. Ream all conduit ends and fit with an insulated throat nylon bushing with non-indenter type malleable steel fittings to eliminate sharp edges.
   h. Telecommunications conduits should not be routed over or adjacent to heat sources such as boilers, hot water lines, or steam lines. Neither should they be routed near large motors, generators, photocopy equipment, or electrical power cabling and transformers.
   i. Conduits that enter an EF/ER/TR must terminate near the corners to allow for proper cable racking. Terminate these conduits as close as possible to the

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wall where the backboard is mounted to minimize the cable route.

j. Terminate conduits that protrude through the structural floor 1” to 3” above the surface within an EF/ER/TR.

k. After installation, conduits shall be clean, dry, unobstructed, capped for protection, labeled for identification, reamed and fitted with bushings.

l. A 200lb pull cord (nylon, 1/8” minimum) shall be installed in any empty conduit.

m. When the number of conduits requires more than one row, restrict the number of rows to two wherever practicable.

5. Pull Box Requirements:

a. NEC sized pull boxes are not acceptable. Follow BICSI and EIA/TIA 569-B guidelines for pull box sizing.

b. Provide pull boxes in sections of conduit that are 100 feet or longer, contain more than two 90 degree bends, or contain a reverse bend.

c. Conduits that enter the pull box from opposite ends should be aligned.

d. Pull boxes shall have a length 12 times the diameter of the largest conduit.

e. All pull boxes must be accessible.

B. Cabling System:

a. Follow T568B for copper cabling terminations.

b. Backbone cables shall be installed separately from horizontal distribution cables. All backbone cables will be run in orange innerduct. Provide plenum rated innerduct if required, innerduct must be appropriate for the environment in which it is installed.

c. All horizontal cables, regardless of media type, shall not exceed 90 m (295 ft) from the telecommunications outlets in the work area to the horizontal cross connect.

C. Grounding System:

1. All grounding and bonding shall be done according to ANSI J-STD-607-A, TIA 942, and NEC.

2. All cabinets/racks shall utilize paint piercing grounding washers, to be used where rack sections bolt together, on both sides, under the head of the bolt and between the nut and rack.

3. Bond cable tray, raceway system, structural steel and all other metal equipment located within EF/ER/TR utilizing copper conductors per the following schedule:

a. ≤25’ - #4
b. ≤50’ - #1
c. ≤75’ - #2/0
d. ≥75’ - #3/0

To the grounding bus bar.

4. Provide 4” X 12” X ¼” CU Telecommunication Main Grounding Bus Bar (TMGB) with bonding conductor per schedule above to Intersystem Bonding Terminal in room with main cross-connect MC (EF/ER/TR).

5. Provide 2” X 12” X ¼” CU Telecommunication Grounding Bus Bar (TGB) with bonding conductor per schedule above to TMGB in each room with an HC.

6. Refer to electrical diagrams for additional ground connection requirements.

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D. Firestopping:

1. Provide firestop solution equivalent to the wall/ceiling/floor rating.

PART 4 – LABELING

4.1 GENERAL

A. The contractor shall develop and submit for approval a labeling system for the cable installation. The Owner will negotiate an appropriate labeling scheme with the successful contractor. At a minimum, the labeling system shall clearly identify all components of the system: racks, cables, panels and outlets. The labeling system shall designate the cables origin and destination and a unique identifier for the cable within the system. Racks and patch panels shall be labeled to identify the location within the cable system infrastructure. All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme.

B. All telecommunications spaces, pathways, cables, connecting hardware, equipment, racks, patch panels, outlet/connectors, and grounding system shall be labeled in accordance with TIA/EIA 606-A.

C. Handwritten labels are not allowed.

D. Provide laminated plans (minimum size 11x17) of all telecommunications as-built plans (including riser diagrams) in each and every EF, ER, and TR.

4.2 TELECOMMUNICATION PATHWAYS

A. Identify each dedicated pathway (including inner ducts) for the voice and data system.

B. Label pathways at regular intervals and wherever they are accessible.

4.3 TELECOMMUNICATION CABLES

A. Identify cables at each end with a permanent label or physical/electronic tag.

1. The same alphanumeric identifiers should be used at both ends of the cable.
2. Identify cables at regular intervals throughout and wherever they are accessible.
3. Cables shall be identified by a self-adhesive label in accordance with the System Documentation Section of this specification and ANSI/TIA/EIA-606-A. The cable label shall be applied to the cable behind the faceplate that can be accessed by removing the cover plate and to the cable behind the patch panel on a section of cable that can be viewed without removing the bundle support ties. Cables labeled within the bundle where the label is obscured from view shall not be acceptable.

4.4 CONNECTING HARDWARE

A. Identify connecting hardware items (termination blocks, cross-connects, racks, cabinets, patch panels, telecommunications outlet/connectors, ports) using alphanumeric identification such as the following three-level scheme:

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1. First level—Termination field or patch panel. Color-coding or other labeling should be used to uniquely identify each termination field (e.g., voice and data) on a common mechanical assembly.
2. Second level—Terminal block within a given field or patch panel, which could be a row of insulation displacement connectors (IDCs), optical fiber connectors, or modular jacks.
3. Third level—Defines the individual position within a given terminal block or patch panel.

4.5 TELECOMMUNICATIONS GROUNDING SYSTEM

A. Identify each telecommunications grounding bus bar (TGB) and telecommunications main grounding bus bar (TMGB).

B. Identify each grounding conductor relating to the telecommunications system, including those connecting building steel, grounding electrodes, water pipes, and telecommunications structural components.

PART 5 - MISCELLANEOUS

5.1 TESTING:

A. Utilize Level 4 Tester to test all equipment and each outlet, horizontal cable, termination block, patch cords, etc. to verify compliance with requirements. Testing shall consist of industry accepted verification tests for the Category of cable installed and shall meet latest requirements of EIA/TIA cabling Standards.

B. Correct any malfunctions. Contractor shall reterminate/replace any cable, connection, or equipment found to be defective or non-compliant with these specifications and referenced standards.

C. Provide test reports electronically and update O&M manuals to include test reports.

5.2 WARRANTY:

A. Provide a 25 year extended product warranty for all cabling from the cabling manufacturer. Include replacement material for any defective product.

5.3 OPERATING AND MAINTENANCE MANUALS / AS-BUILT DRAWINGS:

A. Operating and maintenance manuals shall be submitted prior to testing of the system. A total of (4) hard copy O&M manuals and an Adobe PDF of the entire O&M manual shall be delivered to the Owner. Manuals shall include all service, installation, and programming information.

B. The As-Built drawings are to include cable routes and outlet locations. Their sequential number as defined elsewhere in this document shall identify outlet locations. Numbering, icons, and drawing conventions used shall be consistent throughout all documentation provided. The Owner will provide floor plans in paper and electronic (DWG) formats on which as-built construction information can be added. These documents will be modified

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accordingly by the telecommunications contractor to denote as-built information as defined above and returned to the Owner.

5.4 TRAINING:

A. Provide four hours training on the operation and installation of the data system, at job site, at no cost to owner.

5.5 RECORD DRAWINGS:

A. Provide a complete set of "as built" drawings showing cabinets, racks, patch panels, wiring, specific interconnections between all equipment and internal wiring of equipment.

END OF SECTION 16741

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SECTION 16770 - CLOSED CIRCUIT TELEVISION

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK:

A. Provide a complete and operating 100% solid-state, color video system complete with cameras, monitors, protective enclosures, lenses, mounting hardware, cables, switching equipment and other such products, equipment and wiring normally and reasonably required for the operation of a complete video surveillance and digital recording system.

1.2. QUALITY ASSURANCE:

A. Equipment shall conform to the requirements of FCC and EIA rules and regulations including EIA standard RS-170A covering color television equipment.

1.3. SUBMITTALS:

A. PRODUCT DATA: Submit manufacturer's data on closed circuit TV and recording systems including, but not limited to, roughing-in diagrams and instructions for installation, operating and maintenance, suitable for inclusion in maintenance manuals. Also include standard or typical riser and complete wiring diagrams for controls and system components.

B. SHOP DRAWINGS: Provide shop drawings showing equipment/device locations and connecting wiring of entire CCTV system. Include wiring diagrams and riser diagrams.

PART 2 PRODUCTS

2.1. ACCEPTABLE MANUFACTURER'S AS SPECIFIED:

A. Exterior pre-packaged camera dome housing assembly with pan-tilt zoom: The camera shall be a variable/high-speed, domed camera with an integral 360° pan/tilt and integral receiver/driver in a NEMA 3 enclosure.

B. DOME PAN-TILT-ZOOM CONTROLLER: The controller shall be compatible with facilities pan-tilt-zoom cameras. The control unit joystick shall include integral camera zoom lens control, allowing one hand operation.

C. INTERIOR PRE-PACKAGED FIXED CAMERA/LENS/DOME HOUSING ASSEMBLY: The camera/lens/housing shall include a high resolution color camera.

D. DIGITAL VIDEO RECORDING SYSTEM: 16 Input Digital Video Recording System. The digital video management system design shall be a microprocessor-based video processor, multiplexer and recorder

PART 3 EXECUTION

3.1. INSTALLATION:

A. General: Comply with manufacturer's written instructions and in accordance with recognized industry practices.

END OF SECTION 16770

SECTION 16781 - TELEVISION SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

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

B. Division-16 Basic Materials and Methods sections apply to work specified in this section.

1.2 DESCRIPTION OF WORK

A. The system shall receive and distribute signals from a cable system. Digital TV stations shall be distributed on channel.

B. Coordinate the installation with the local CATV company to be sure that the cable drop provides a signal of at least +10 dBmV flat.

C. The work of this section includes electrical raceways (minimum 3/4") cable, boxes, and fittings, as specified in applicable Division-26 Basic Materials and Methods section, which are used to enclose TV cabling.

1.3 SUBMITTALS:

A. Product Data: Submit manufacturer's data on televisions systems and accessories.

PART 2 – PRODUCTS

2.1 GENERAL:

A. The Contractor shall ascertain the requirements of the project and shall provide any taps, filters, outlets or cables required to achieve the specified performance and provide a picture at any outlet equal to the quality of that of signals directly from the cable tray.

2.2 EQUIPMENT

A. Equipment as specified is manufactured by Blonder Tounge, West Penn and Pico Macom. Equal of Jerold, Scientific Atlanta, Belden or Times Fiber shall be accepted.

PART 3 – EXECUTION

3.1 INSTALLATION OF TELEVISION SYSTEMS:

A. Install television systems and ancillary equipment as indicated in accordance with equipment manufacturer's written instructions, and the NEC, and with recognized industry practices, to insure that television systems fulfill requirements.

3.2 GROUNDING:

A. Provide equipment grounding connections, sufficiently tight to assure a permanent and effective ground, for system components, antennas and supporting structures, as indicated. Provide connection to IBT grounding bus per diagram.

3.3 FIELD QUALITY CONTROL

A. Testing:

1. Upon completion of installation of TV system and after electrical circuitry has been energized, test capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrated compliance; otherwise, remove and replace with new units, and proceed with retesting. Provide calibrated field strength meter and color TV set for testing.

END OF SECTION 16781

SECTION 16783 – SECURITY SYSTEM

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK

A. Provide access control system as is hereby defined to include, but not be limited to raceway, outlets, coverplates, backboards, cabinets, grounding and miscellaneous items required for complete system.

B. SYSTEM DESCRIPTION

1. The Security Management System specified shall be fully integrated and installed as a complete package by the Access/Security Control Contractor. The SMS shall be able to provide for and integrate the following subsystems:

a. Integrated Access Control.
b. Alarm Monitoring.
c. Associated Access Control and Alarm Equipment Control.
d. Access Initiated and Event Initiated Control

The SMS shall be based upon a distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on a true peer-to-peer, token passing Local Area Network (LAN).

1.2 SUBMITTALS:

A. Product Data: Submit manufacturer's data: Typical riser and complete wiring diagrams.

B. SHOP DRAWINGS: Provide shop drawings showing equipment/device locations and connecting wiring.

PART 2 – PRODUCTS

2.1 GENERAL: Provide and install a complete and operable access control system which utilize devices to maintain building security.

A. Acceptable manufacturers:

1. Security access system:

a. I/NET as manufactured by TAC Inc.
b. WIN DSX

B. Materials: Furnish and install at locations shown, the specified equipment to provide a completely operational Access Control/Security Management system. The following list of main items of the installation shall not be considered to be all-inclusive:

1. Door hardware and accessories
2. Readers
3. Monitors

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4. Distributed Control Units (DCU's) – Main Controller
5. Door Processing Units (DPU's) – Main Door Controllers
6. Alarm relays
7. Miscellaneous cable, wire, associated connectors, and hardware
8. Power supplies

C. All materials and equipment shall be standard, regularly manufactured equipment.

D. All systems and components shall be thoroughly tested and proven in actual field use.

E. All system main control components shall be from one manufacturer.

2.2 HARDWARE SPECIFICATIONS - 7920 DOOR CONTROLLERS

2.3 HARDWARE SPECIFICATIONS - 7930 DIGITAL INPUT CONTROLLER

2.4 HARDWARE SPECIFICATIONS - 7940 DIGITAL INPUT/OUTPUT CONTROLLER

2.5 HARDWARE SPECIFICATIONS - 7798 I/SITE LAN CONTROLLER

2.6 HARDWARE SPECIFICATIONS - 7793 MICRO CONTROLLER INTERFACE

2.7 HARDWARE SPECIFICATIONS - 7800 SERIES TAPS

2.8 HARDWARE SPECIFICATIONS NETPLUS ROUTER (NPR)

2.9 HARDWARE SPECIFICATIONS – READERS

2.10 PROXIMITY READERS

PART 3 – EXECUTION

3.1 INSTALLATION OF ACCESS CONTROL SYSTEM

A. GENERAL: Install access control system as indicated, in accordance with equipment manufacturers written instructions, and with recognized industry practices, to ensure that system equipment complies with requirements. Comply with requirements of NEC, and applicable portions of NECA's "Standards of Installation" practices.

1. FINAL ACCEPTANCE TEST:

a. After the testing report and as built drawings have been approved by the customer's representative, the completed system shall be tested in the presence of the customer's representative.

B. GROUNDING

1. Take particular attention to the grounding of equipment cases and shielded cables to eliminate noise interference and avoid electrical loops. Provide shielded cable for all communications cabling. Correctly terminate shields at ground bars and connect to the main building ground or as specified by the manufacturer.

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C. Coordinate all equipment locations and mounting details with other trades and suppliers.

END OF SECTION 16783

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SECTION 16785 - SOUND REINFORCEMENT AND PLAYBACK SYSTEMS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

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

B. Division 16 Basic Materials and Methods sections apply to work specified in this section.

1.2 DESCRIPTION OF WORK:

A. Provide the specified systems in a complete and operating condition with all necessary materials and labor to fulfill the requirements and the intent of the specifications.

B. QUALIFICATIONS: Any system and/or equipment proposed as an equal to that specified must be proven to conform to the standards established herein. Refer to Electrical General Provisions for substitution procedures.

1.3 SUBMITTALS:

A. PRODUCT DATA: Submit manufacturer's data sheet including specifications, installation instructions, and general recommendations for each piece of equipment specified.

PART 2 – PRODUCTS:

2.1 THEATER ROOM SYSTEM:

A. The system shall provide sound reproduction of signals originating from television, DVD player and auxiliary sources.

B. The system shall employ loudspeakers. Orient the speakers to provide coverage. The sound contractor shall coordinate all requirements.

C. The work of this section includes electrical raceways, boxes and fittings as specified in applicable Division 16 Basic Materials and Methods sections, which are used to enclose sound cabling. Equipment backboxes are also included.

PART 3 – EXECUTION

3.1 WIRING:

A. Wiring shall be installed in metallic conduit and provided with necessary junction and pull boxes. All wiring shall be color coded and in accordance with the manufacturer's instructions, local and national codes.

3.2 INSTALLATION OF SOUND SYSTEMS:

A. Install sound systems as indicated, in accordance with equipment manufacturer's instructions, and with recognized industry practices, to ensure that system equipment complies with requirements. Comply with requirements of NEC and applicable portions of NECA's "Standard

of Installation" practices.

3.3 GROUNDING:

A. Provide equipment grounding connections, sufficiently tight to assure permanent and effective ground.

3.4 FIELD QUALITY CONTROL:

A. TESTING: Upon completion of installation of sound system and after electrical circuitry has been energized, demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed retesting.

END OF SECTION 16785

SECTION 16786 - CLOCKS

PART 1–GENERAL

1.1. DESCRIPTION OF WORK

A. Types of equipment included in this section are:

1. Synchronous-Wired Secondary Clocks.
2. Double Dial Clocks

1.2. SYNCHRONOUS WIRED SECONDARY CLOCKS:

A. Provide secondary clocks in locations shown on drawings. Provide 12" (round) (square) semi-flush clocks with black hands and numerals displayed against a (white) background. Equip clock with metal case, sweep second hand, and synchronous motor with correction armature. Construct clock to individually and automatically correct. Provide an appropriate backbox.

1.3. ACCEPTABLE MANUFACTURES: As specified:

1.4. DOUBLE DIAL CLOCKS:

A. Provide 12" double dial clocks of same type as secondary clocks in locations shown. Provide necessary back boxes.

PART 2- EXECUTION

2.1. INSTALLATION OF CLOCK SYSTEMS:

A. Coordinate with other electrical work, including cable/wires, raceways, electrical boxes and fittings, as appropriate to interface installation of clocks work with other work.

END OF SECTION 16786

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