FINAL SUBMITTAL

2251 N. PALAFOX
CHILLER REPLACEMENT II

PENSACOLA, FLORIDA

19 August 2016

SPECIFICATIONS

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JOB NO. 13140

DIVISION 23 – MECHANICAL

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SECTION 23 05 00 - MECHANICAL GENERAL REQUIREMENTS

1.1 APPLICATION:

A. This section applies to all sections of Division 23, "Mechanical" of this project.

1.2 REFERENCES:

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

CODE OF FEDERAL REGULATIONS (CFR)

29 CFR 1910.147, Control of Hazardous Energy
(Lock Out/Tag Out)

1.3 GENERAL:

A. The contract drawings indicate the extent and general arrangement of the work. The contractor shall be responsible for installing the proposed systems as indicated, without violation of applicable codes, standards, or specification requirements. The contractor is also responsible for coordinating the installation and operation of these systems with the other sections of this specification to provide a complete and operable system. Items shall be arranged such that they fit the space as indicated and shall allow adequate and approved clearance for entry, servicing and maintenance. Detailed drawings of any proposed departures due to actual field conditions shall be submitted to the Engineer for approval. All work shall conform to the requirements of the referenced publications and as specified herein.

1.4 CONFORMANCE WITH AGENCY REQUIREMENTS:

A. Where materials or equipment are specified to conform to requirements of the Underwriters' Laboratories, Inc., or other agency, institute, codes, councils or regulatory bodies, the contractor shall submit proof of such conformance. The label or listing of the specified agency will be acceptable evidence. In lieu of the label or listing, the contractor may submit a written certificate from any approved, nationally recognized testing organization adequately equipped and competent to perform such services, stating that the items have been tested and that the units conform to the requirements, including methods of testing, of the specified agency. Where equipment is specified to conform to requirements of the ASME Boiler and Pressure Vessel Code, the design, fabrication, and installation shall conform to the code in every respect and bear the ASME stamp.

1.5 CAPACITIES:

A. Capacities of all equipment and material shall be as indicated in the specifications or shown on the drawings. The Engineer can accept equipment, which may be less than the indicated values in a certain area if its clear the intent of the requirements is fulfilled.

1.6 EQUIPMENT INSTALLATION:

A. Necessary supports shall be provided for equipment and systems components as

required. Isolation vibration and systems components units shall be provided to minimize the intensity of vibration transmission to the building structure where required. Concrete pads shall be provided for all outside equipment installed. The pads shall extend 6" pass the unit on all sides.

1.7 ELECTRICAL WORK:

A. Electric-motor-driven equipment specified herein shall be provided complete with motors and controls. Electric equipment and wiring shall be in accordance with Division 26, "Electrical". Electrical characteristics shall be as indicated. Each motor shall be of sufficient capacity to drive the equipment at the specified capacity without exceeding the nameplate rating of motor when operating at proper electrical system voltage. Manual or automatic control and protective or signal devices required for the operation herein specified and any control wiring required for controls and devices, but not shown on the electrical plans, shall be provided under this section as required, this includes 120 volt power wiring to power the controls.

1.8 SUBMITTAL OF MATERIALS AND EQUIPMENT FOR APPROVAL:

A. Before purchasing any materials or equipment, the contractor shall submit for approval, in five bound copies, data of the materials he proposes for the work. Items to be submitted include, but are not limited to, the items listed in each individual section. Partial submittals will not be acceptable and will be returned without review. Submittals shall include the manufacturer's names, trade name, catalog model or number, nameplate data, size, layout dimensions, capacity, project specification and paragraph reference, applicable Federal, Military, industry, and technical society publication references, and other information necessary to establish contract compliance of each item the contractor proposes to furnish.

1. Shop Drawings. Drawings shall be a minimum of 8.5 inches by 11 inches in size, except as specified otherwise.

2. Manufacturer's Data. Submittals for each manufactured item shall be manufacturer's descriptive literature of cataloged products, equipment drawings, diagrams, performance and characteristic curves, catalog cuts, and manufacturer's installation recommendations.

3. Cataloged Products. Materials and equipment shall be cataloged products of manufacturers regularly engaged in production of such materials or equipment and shall be manufacturer's latest design that complies with the specification requirements. Materials and equipment shall duplicate items that have been in satisfactory commercial or industrial use at least 2 years prior to bid opening. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the items need not be the products of the same manufacturer.

4. Submittal Organization. The submittal shall be organized in the same order as the specification sections. The cut sheets shall be marked with equipment number which is shown on the drawings or name for something general such as piping. The submittal sheets shall document the piece of equipment meets the performance requirements of the contract documents. Note: Unmarked submittals will be rejected without review.

5. Samples. The samples shall be such as to illustrate the functional and aesthetic characteristics of the product.

6. Equipment Application. The contractor shall note on the submittal or in writing of any equipment provided which may not operate satisfactory when installed as indicated on the plans.

1.9 NAMEPLATES:

A. Each major item of equipment shall have the manufacturer's name, address, date of manufacture, serial and model numbers on a plate securely attached to the item.

1.10 VERIFICATION OF DIMENSIONS:

A. The contractor shall visit the premises to thoroughly familiarize him with all details of the work and working conditions and verify all dimensions in the field, and shall advise the Engineer of any discrepancy before performing any work. The contractor shall be specifically responsible for the coordination and proper relation of his work to other structures and to the work of all other trades.

1.11 DRAWINGS:

A. Because of the scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that are required. The contractor shall carefully investigate the structural and finish conditions affecting his work and he shall furnish fittings, offsets, transitions, unions, etc., as may be required to meet such conditions at no additional cost to the Owner.

1.12 CUTTING AND REPAIRING:

A. The work shall be carefully laid out in advance and no excessive cutting of construction will be permitted. Damage to building, piping, wiring, or equipment as a result of cutting for installation shall be repaired by mechanics skilled in the trade involved at no additional expense to the Owner.

1.13 SAFETY REQUIREMENTS:

A. Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts located so that any person can come in close proximity thereto shall be fully enclosed or properly guarded. High-temperature equipment and piping so located as to endanger personnel or create a fire hazard shall be properly guarded or covered with insulation of a type as specified herein. Items such as catwalks, ladders, and guardrails shall be provided where required for safe operation and maintenance of equipment.

1.14 MANUFACTURER'S RECOMMENDATIONS:

A. Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished to the Owner prior to installation. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material.

1.15 PAINTING:

A. At the completion of all work, all equipment on this project shall be checked for damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas. Any metal item that has been provided which has not been painted or otherwise protected shall be painted with primer and final coating as recommended by the paint manufacture for the particular application.

1.16 FINAL CLEANUP:

A. At the completion of all work, all equipment on the project shall be checked and thoroughly cleaned, including coils, plenums, under equipment, and any and all other areas around or in equipment. Any filters used during construction shall be replaced with new filters during final cleanup.

1.17 OPERATING AND MAINTENANCE INSTRUCTIONS:

A. Bound instructions. Three complete sets of instructions containing the manufacturer's operating and maintenance instructions for each piece of equipment shall be furnished to the Owner before the contract is completed. Each set shall be permanently bound and shall have a hard cover. The following identification shall be inscribed on the covers: The words "Operating and Maintenance Instructions", the name and location of the building, the name of the contractor and the contract number. Flysheet shall be placed before instructions covering each subject. The instruction sheet shall be approximately 8-1/2 by 11 inches, with large sheets of drawings folded in. The instructions shall include, but shall not be limited to, the following:

1. Approved wiring and control diagrams, with data to explain the detailed operation and control of each component.

2. A control sequence describing startup, operation and shutdown.

3. Operating and maintenance instructions for each piece of equipment, including lubrication instructions.

4. Manufacturer's bulletins, cuts and descriptive data.

5. Parts list and recommended spare parts.

B. Framed Instructions. Approved wiring and control diagrams showing the complete layout of the entire system, including equipment, piping, valves and control sequence, framed under glass or in approved laminated plastic, shall be posted, where directed. In addition, condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system shall be prepared in typed form framed as specified above for the wiring and control diagrams and posted beside the diagram. Proposed diagrams, instructions, and other sheets shall be submitted prior to posting. The framed instructions shall be posted before acceptance testing of the system.

1.18 DELIVERY AND STORAGE:

A. Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with

the manufacturer's recommendations. Damaged or defective items shall be replaced.

1.19 LOCKOUT OF ENERGY SOURCES:

A. Provide appropriate lockout devices for energy isolating valves and for machines or other equipment to prevent unexpected start-up or release of stored electrical, mechanical, hydraulic, pneumatic, thermal, chemical, or other energy in accordance with 29 CFR 1910.147. Lockout devices for valves shall provide a means of attachment to which, or through which, a lock can be affixed or shall have a locking mechanism built into it so that the valve cannot be moved from the lockout position until the lock is removed. Electrical isolation of machines or other equipment shall be in accordance with requirements of Division 26 "Electrical."

1.20 PROJECT RECORD DOCUMENTS

A. Maintain on site one set of the following record documents; record actual revisions to the work:

1. Drawings.
2. Specifications.
3. Addenda.
4. Change orders and other modifications to the contract, reviewed shop drawings, product data, and samples, manufacturer's instruction for assembly, installation, and adjusting.

B. Ensure entries are complete and accurate, enabling future reference by Owner.

C. Store record documents separate from documents used for construction.

D. Record information concurrent with construction progress.

E. Specifications: Legibly mark and record at each product section description of actual products installed, including the following:

1. Manufacturer's name and product model and number.
2. Product substitutions or alternates utilized.
3. Changes made by addenda and modifications.

F. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction including:

1. Measured depths of foundations in relation to finish floor datum.
2. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
3. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the work.
4. Field changes of dimensions and details.
5. Details not on original contract drawings.

G. Submit documents to Owner upon completion of project.

1.21 EQUIPMENT DRAINS

A. The contractor shall mount air-handling units on rails or bases as required to provide enough clearance for the condensate traps.

1.22 ENERGY CODE

A. The equipment installation and ductwork shall meet the requirements of the Florida Energy Code or as required by the specifications whichever is more stringent.

1.23 TRAINING/START UP

A. The contractor shall meet on the site after the job is complete and review the systems operation with the building manager and maintenance personnel. During the review the contractor shall verify that all system settings and timetables are satisfactory with the building manager.

END OF SECTION 23 05 00

SECTION 23 05 19 - GAGES AND METERS

PART 1 GENERAL

1.1 SECTION INCLUDES (SUBMITTAL REQUIRED FOR EACH ITEM)

A. Pressure gages and Pressure gage taps.

B. Thermometers and thermometer wells.

C. Test plugs.

1.2 RELATED SECTIONS

A. Section 23 05 00 - Mechanical General Requirements.

1.3 REFERENCES

A. ASME B40.1 Gages - Pressure Indicating Dial Type - Elastic Element.

B. ASTM E1 - Specification for ASTM Thermometers.

C. ASTM E77 - Verification and Calibration of Liquid-in-Glass Thermometers.

D. UL 393 - Indicating Pressure Gages for Fire and Protection Services.

E. UL 404 - Gages, Indicating Pressure, for Compressed Gas Service.

1.4 SUBMITTALS

A. Submit under provisions of Section 23 05 00.

B. Product Data: Provide list which indicates use, operating range, total range and location for manufactured components.

C. Provide one test kit with gauges and thermometers as indicated in the specifications.

PART 2 PRODUCTS

2.1 PRESSURE GAGES

A. Gage: ASME B40.1, UL 393 UL 404, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white

background.

1. Case: Cast aluminum with phosphor bronze bourdon tube.
2. Size: 4-1/2 inch diameter.
3. Mid-Scale Accuracy: One percent.
4. Scale: Psi.

2.2 PRESSURE GAGE TAPPINGS

A. Gage Cock: Tee or lever handle, brass for maximum 150 psig.

B. Pulsation Damper: Pressure snubber, brass with 1/4 inch connections.

2.3 STEM TYPE THERMOMETERS

A. Thermometer: ASTM E1, adjustable angle, trerice blue mercury free, lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device.

1. Size: 12 inch scale.
2. Window: Clear Lexan.
3. Stem: 3/4 inch NPT brass.
4. Accuracy: ASTM E77 1 percent.
5. Calibration: Degrees F.

2.4 DIAL THERMOMETERS

A. Thermometer: ASTM E1, stainless steel case, adjustable angle with front recalibration, bimetallic helix actuated with silicone fluid damping, white with black markings and black pointer hermetically sealed lens, stainless steel stem.

1. Size: 5 inch diameter dial.
2. Lens: Clear Lexan.
3. Accuracy: 1 percent.
4. Calibration: Degrees F

2.5 THERMOMETER SUPPORTS

A. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.

2.6 TEST PLUGS

A. Test Plug: 1/4 inch or 1/2 inch brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with neoprene core for temperatures up to 200 degrees F.

B. Test Kit: Carrying case, internally padded and fitted containing two 3-1/2 inch diameter pressure gages, two gage adapters with 1/8 inch probes, two 1-1/2 inch dial thermometers.

The gauges for the test kit shall be the calibrationable type.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install all instruments and plugs in accordance with manufacturer's instructions.

B. Provide one pressure gage per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gage.

C. Install pressure gages with pulsation dampers. Provide gage cock to isolate each gage. Extend nipples to allow clearance from insulation.

D. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.

E. Install thermometer sockets adjacent to controls systems thermostat, transmitter, or sensor sockets.

F. Install gages and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

G. Adjust gages and thermometers to final angle, clean windows and lenses, and calibrate to zero.

H. Air duct thermometers shall have perforated stem guards and 45-degree adjustable duct flanges with locking mechanisms.

I. Thermometers shall have the ranges as indicated or to the following application table:

1. Mixed air temperature: 0 to 100 degrees F in 1-degree graduations.

2. Return air temperature: 0 to 100 degrees F in 1-degree graduations.

3. Cooling coil discharge temperature: 0 to 100 degrees in 1-degree F graduations.

4. Heating coil discharge temperature: 30 to 180 degrees in 2-degree F graduations.

5. Hydronic heating systems below 220 degrees F: 40 to 240 degrees F in 2-degree graduations.

6. Chilled water temperature: 0 to 100 degrees F in 1-degree F graduations.

7. Condenser water temperature: 40 to 140 degrees in 1-degree F graduations.

J. The gauges ranges shall go from zero pounds per square inch to 1.5 time maximum normal pressure of system or as indicated.

K. Provide one test kit with gauges and thermometers as specified.

END OF SECTION 23 05 19

SECTION 23 05 29 - SUPPORTS AND ANCHORS

PART 1 GENERAL

1.1 SECTION INCLUDES (SUBMITTAL REQUIRED FOR EACH ITEM)

A. Pipe and equipment hangers and supports.

B. Equipment bases and supports.

C. Sleeves and seals.

D. Flashing and sealing equipment and pipe stacks.

1.2 RELATED SECTION

A. Section 23 05 00 - General Mechanical Requirements.

1.3 REFERENCES

A. ASME B31.1 - Power Piping

B. ASME B31.2 - Fuel Gas Piping

C. ASME B31.5 - Refrigeration Piping

D. ASME B31.9 - Building Services Piping

E. ASTM F708 - Design and Installation of Rigid Pipe Hangers.

F. MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacture.

G. MSS SP69 - Pipe Hangers and Supports - Selection and Application.

H. MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

I. NFPA 13 - Installation of Sprinkler Systems.

J. NFPA 14 - Installation of Standpipe and Hose Systems

K. UL 203 - Pipe Hanger Equipment for Fire Protection Service

1.4 SUBMITTALS

A. Submit under provisions of Section 23 05 00.

B. Shop Drawings: Indicate system layout with location and detail of trapeze hangers.

C. Product Data: Provide manufacturers catalog data including load capacity and all features required by the specifications.

D. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.

E. Manufacturer's Installation Instructions: Indicate special procedures and assembly of components.

1.5 REGULATORY REQUIREMENTS

A. Conform to applicable code for support of piping.

B. Supports for Sprinkler Piping: In conformance with NFPA 13.

C. Supports for Standpipes: In conformance with NFPA 14.

PART 2 PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

A. Fire Protection Piping:

1. Conform to NFPA 13 NFPA 14.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch): Malleable iron or Carbon steel, adjustable swivel, split ring.
3. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
5. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
6. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp.
7. Vertical Support: Steel riser clamp.
8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
9. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

B. Plumbing Piping - DWV:

1. Conform to ASME B31.9 ASTM F708 MSS SP58 MSS SP69 MSS SP89.

2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Malleable iron or Carbon steel, adjustable swivel, split ring.
3. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
5. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
6. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp.
7. Vertical Support: Steel riser clamp.
8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
9. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

C. Plumbing Piping - Water:

1. Conform to ASME B31.9 ASTM F708 MSS SP58 MSS SP69 MSS SP89.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Malleable iron or Carbon steel, adjustable swivel, split ring.
3. Hangers for Cold Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe Sizes 2 to 4 Inches: Carbon steel, adjustable, clevis.
5. Hangers for Hot Pipe Sizes 6 Inches and Over: Adjustable steel yoke, cast iron roll, double hanger.
6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 Inches and Over: Steel channels with welded spacers and hanger rods, cast iron roll.
8. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
9. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp.
10. Wall Support for Hot Pipe Sizes 6 Inches and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
11. Vertical Support: Steel riser clamp.
12. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
13. Floor Support for Hot Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
14. Floor Support for Hot Pipe Sizes 6 Inches and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
15. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

D. Hydronic Piping:

1. Conform to ASME B31.9 ASTM F708 MSS SP58 MSS SP69 MSS SP89.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Malleable iron or Carbon steel, adjustable swivel, split ring.

3. Hangers for Cold Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe Sizes 2 to 4 Inches: Carbon steel, adjustable, clevis.
5. Hangers for Hot Pipe Sizes 6 Inches and Over: Adjustable steel yoke, cast iron roll, double hanger.
6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 Inches and Over: Steel channels with welded spacers and hanger rods, cast iron roll.
8. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
9. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp.
10. Wall Support for Hot Pipe Sizes 6 Inches and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
11. Vertical Support: Steel riser clamp.
12. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
13. Floor Support for Hot Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
14. Floor Support for Hot Pipe Sizes 6 Inches and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
15. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

E. Steam and Steam Condensate Piping:

1. Conform to ASME B31.1 MSS SP58 MSS SP69 MSS SP89.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Malleable iron or Carbon steel, adjustable swivel, split ring.
3. Hangers for Pipe Sizes 2 to 4 Inches: Carbon steel, adjustable, clevis.
4. Hangers for Pipe Sizes 6 Inches and Over: Adjustable steel yoke, cast iron roll, double hanger.
5. Multiple or Trapeze Hangers for Pipe Sizes to 4 inches: Steel channels with welded spacers and hanger rods.
6. Multiple or Trapeze Hangers for Pipe Sizes 6 Inches and Over: Steel channels with welded spacers and hanger rods; cast iron roll and stand.
7. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
8. Wall Support for Pipe Sizes 4 to 5 Inches: Welded steel bracket and wrought steel clamp.
9. Wall Support for Pipe Sizes 6 Inches and Over: Welded steel bracket and wrought steel clamp; adjustable steel yoke and cast iron roll.
10. Vertical Support: Steel riser clamp.
11. Floor Support for Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
12. Floor Support for Pipe Sizes 6 Inches and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
13. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

F. Refrigerant Piping:

1. Conform to ASME B31.5 MSS SP58 MSS SP69 MSS SP89.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch (13 to 38 mm): Malleable iron or Carbon steel, adjustable swivel, split ring.
3. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
5. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
6. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp.
7. Vertical Support: Steel riser clamp.
8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
9. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

2.2 ACCESSORIES

A. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

2.3 INSERTS

A. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.4 FLASHING

A. Metal Flashing: 26 gage galvanized steel.

B. Metal Counterflashing: 22 gage galvanized steel.

C. Lead Flashing:
1.Waterproofing: 5 lb/sq ft sheet lead
2.Soundproofing: 1 lb/sq ft sheet lead.

D. Flexible Flashing: 47 mil thick sheet butyl; compatible with roofing.

E. Caps: Steel, 22 gage minimum; 16 gage at fire resistant elements.

2.5 EQUIPMENT CURBS

A. Fabrication: Welded 18 gage galvanized steel shell and base, mitered 3 inch cant, variable step as required to match roof insulation, 1-1/2 inch thick insulation, factory

installed wood nailer.

2.6 SLEEVES

A. Sleeves for Pipes Through Non-fire Rated Floors: 18 gage galvanized steel.

B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Schedule 40 galvanized steel pipe.

C. Sleeves for Pipes Through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed.

D. Sleeves for Round Ductwork: Galvanized steel.

E. Sleeves for Rectangular Ductwork: Galvanized steel or wood.

F. Stuffing Insulation: Glass fiber type, non-combustible.

G. Sealant: Acrylic.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

3.2 INSERTS

A. Provide inserts for placement in concrete formwork.

B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.

D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

3.3 PIPE HANGERS AND SUPPORTS

A. Support horizontal piping as scheduled or required by Code whichever is more strigent.

B. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

C. Place hangers within 12 inches of each horizontal elbow.

D. Use hangers with 1-1/2 inch minimum vertical adjustment.

E. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.

F. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.

G. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

H. Support riser piping independently of connected horizontal piping.

I. Provide copper plated hangers and supports for copper piping.

J. Design hangers for pipe movement without disengagement of supported pipe.

K. Coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

3.4 EQUIPMENT BASES AND SUPPORTS

A. Provide housekeeping pads of concrete, minimum 6 inches thick with reinforcement bars and extending 6 inches beyond supported equipment.

B. Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.

C. Construct supports of steel members. Brace and fasten with flanges bolted to structure.

D. Provide rigid anchors for pipes after vibration isolation components are installed.

3.5 FLASHING

A. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.

B. Flash vent and soil pipes projecting 3 inches minimum above finished roof surface with lead worked one inch minimum into hub, 8 inches minimum clear on sides with 24 x 24 inches sheet size. For pipes through outside walls, turn flanges back into wall and calk, metal counterflash, and seal.

C. Seal floor drains watertight to adjacent materials.

D. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms, installed in accordance with manufacturer's instructions for sound control.

E. Provide curbs for mechanical roof installations 14 inches minimum high above roofing surface. Flash and counterflash with sheet metal; seal watertight. Attach counterflashing mechanical equipment and lap base flashing on roof curbs. Flatten and solder joints.

F. Adjust storm collars tight to pipe with bolts; calk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.6 SLEEVES

A. Set sleeves in position in formwork. Provide reinforcing around sleeves.

Size sleeves large enough to allow for movement due to expansion and contraction minimum 1/4". Provide for continuous insulation wrapping.

B. Extend sleeves through floors one inch above finished floor level. Calk sleeves.

C. Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with stuffing insulation and calk. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

D. Install chrome plated steel escutcheons at finished surfaces.

3.7 SCHEDULES

PIPE SIZE Inches	MAX. HANGER SPACING Feet	HANGER ROD DIAMETER Inches
1/2 to 1-1/4	6.5	3/8
1-1/2 to 2	10	3/8
2-1/2 to 3	10	1/2
4 to 6	10	5/8
8 to 12	14	7/8
14 and Over	20	1
PVC (All Sizes)	6	3/8

END OF SECTION 23 05 29

SECTION 23 05 53 - MECHANICAL IDENTIFICATION

PART 1 GENERAL

1.1 SECTION INCLUDES (SUBMITTAL REQUIRED FOR EACH ITEM)

A. Nameplates.

B. Tags.

C. Stencils.

D. Pipe Markers.

1.2 RELATED SECTION

A. Section 23 05 00 - General Mechanical Requirements.

1.3 REFERENCES

A. ASME A13.1 - Scheme for the Identification of Piping Systems.

1.4 SUBMITTALS

A. Submit under provisions of Section 23 05 00.

B. Submit list of wording, symbols, letter size, and color coding for mechanical identification.

C. Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

D. Product Data: Provide manufacturers catalog literature for each product required.

E. Samples: Submit two labels and tags.

F. Manufacturer's Installation Instructions: Indicate special procedures, and installation.

1.5 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 23 05 00.

B. Record actual locations of tagged valves.

PART 2 PRODUCTS

2.1 NAMEPLATES

A. Description: Laminated three-layer plastic with engraved white letters on dark contrasting background color.

2.2 TAGS

A. Plastic Tags: Laminated three-layer plastic with engraved white letters on dark contrasting background color. Tag size minimum 1-1/2 inch square.

********** OR *********

B. Metal Tags: Stainless Steel with stamped letters; tag size minimum 1-1/2 inch square with smooth edges.

C. Chart: Typewritten letter size list in anodized aluminum frame.

2.3 STENCILS

A. Stencils: With clean cut symbols and letters of following size:
   1. 3/4 to 3 inch Outside Diameter of Pipe: 8 inch long color field, ½ inch high letters.
   2. 3-1/2 to 8 inch Outside Diameter of Pipe: 12 inch long color field, 1-1/4 inch high letters.
   3. Over 8 inch Outside Diameter of Insulation or Pipe: 32 inch long color field, 3-1/2 inch high letters.
   4. Ductwork and Equipment: 2-1/2 inch high letters.

B. Stencil Paint: Semi- gloss enamel, colors conforming to ASME A13.1.

2.4 PIPE MARKERS

A. Color: Conform to ASME A13.1.

B. Plastic Pipe Markers: Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed. Pipe markers indicating flow direction shall wrap completely around pipe.

C. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings, minimum information indicating flow direction arrow

and identification of fluid being conveyed. Pipe markers indicating flow direction shall wrap completely around pipe.

D. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

PART 3 EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces in accordance with manufacturer's recommendations for stencil painting.

3.2 INSTALLATION

A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

B. Install tags with corrosion resistant chain.

C. Apply stencil painting in accordance with manufacturer's recommendations.

D. Install plastic pipe markers in accordance with manufacturer's instructions.

E. Install plastic tape pipe markers completely around pipe on all new piping throughout the project and in accordance with manufacturer's instructions.

F. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

G. Identify control panels and major control components outside panels with plastic nameplates.

END OF SECTION 23 05 53

SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Testing, adjustment, and balancing of air systems.

B. Testing, adjustment, and balancing of hydronic systems.

1.2 RELATED SECTIONS

A. Section 23 05 00 - General Mechanical Requirements.

1.3 REFERENCES

A. AABC - National Standards for Total System Balance.

B. ADC - Test Code for Grilles, Registers, and Diffusers.

C. ASHRAE 111 - Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air-conditioning, and Refrigeration Systems.

D. NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

E. SMACNA - HVAC Systems Testing, Adjusting, and Balancing.

1.4 SUBMITTALS

A. Submit under provisions of Section 23 05 00.

B. Submit name of adjusting and balancing agency for approval within 30 days after award of Contract.

C. Field Reports: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance to be submitted 21 days before any installation work.

D. Prior to commencing work, submit report forms or outlines indicating adjusting, balancing, and equipment data required. Include detailed procedures, agenda, and sample report forms.

E. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect/Engineer and for inclusion in operating and maintenance manuals.

F. Provide reports in letter size, 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and

indicating thermostat locations.

G. Test Reports: Indicate data on AABC National Standards for Total System Balance forms or NEBB.

H. Submit second test report for the second test which is to be done approximately 6 months after the first for opposite season operation.

1.5 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 23 05 00.

B. Record actual locations of flow measuring stations balancing valves and rough setting.

1.6 QUALITY ASSURANCE

A. Perform total system balance in accordance with AABC National Standards for Field Measurement and Instrumentation, Total System Balance or NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.

B. The test and balance contractor shall schedule a meeting at the site with the design engineer and spot check 10 to 15% of the readings. If the readings are off by more than 7% the complete building test and balance shall be redone and a new report submitted.

1.7 QUALIFICATIONS

A. Agency: Company specializing in the testing, adjusting, and balancing of systems specified in this section with minimum three years documented experience and certified by AABC, NEBB or Register Professional Engineer with a minimum of 5 year experience in Test and Balance.

B. Perform Work under supervision of AABC Certified Test and Balance Engineer or NEBB Certified Testing, Balancing and Adjusting Supervisor or Register Professional Engineer with a minimum of 5 year experience in Test and Balance.

1.8 SEQUENCING

A. Sequence work to commence after completion of systems and schedule completion of work before Substantial Completion of Project.

B. The Test and Balance Contractor shall work with Controls Contractor as required to adjust the air dampers or water valves to provide the air flows or water flows as required.

1.9 SCHEDULING

A. Schedule work as required to perform the work required.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
   1. Systems are started and operating in a safe and normal condition.
   2. Temperature control systems are installed complete and operable.
   3. Proper thermal overload protection is in place for electrical equipment.
   4. Hydronic systems are flushed, filled, and vented.
   5. Pumps are rotating correctly.
   6. Proper strainer baskets are clean and in place.
   7. Service and balance valves are open.

B. Submit field reports. Report defects and deficiencies noted during performance of services which prevent system balance.

C. Beginning of work means acceptance of existing conditions.

3.2 PREPARATION

A. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect/Engineer to facilitate spot checks during testing.

B. Provide additional balancing devices as required.

3.3 INSTALLATION TOLERANCES

A. Hydronic Systems: Adjust to within plus 5 percent or minus 0 percent of design.

3.4 ADJUSTING

A. Ensure recorded data represents actual measured or observed conditions.

B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

C. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

D. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

E. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.

F. Check and adjust systems approximately six months after final acceptance and submit report for opposite season operation.

3.5 WATER SYSTEM PROCEDURE

A. Measure water flow at the pumps. 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 manufacture's pump curve at zero flow and verify that the pump has the intended impeller size. Adjust water systems to provide required or design quantities. Verify flow readings by measuring the pressure differential across the chiller heat exchanger and note the point on the manufacture's chiller drop curve.

B. Use calibrated fittings and pressure gages to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.

C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.

D. Effect system balance with automatic control valves fully open to heat transfer elements.

E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.

F. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.6 SCHEDULES

A. Equipment Requiring Testing, Adjusting, and Balancing

HVAC Pumps
Air Cooled Water Chillers

END OF SECTION 23 05 93

SECTION 23 07 16 - EQUIPMENT INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES (SUBMITTAL REQUIRED FOR EACH ITEM)

A. Equipment insulation.

B. Covering.

1.2 RELATED SECTION

A. Section 23 05 00 - General Mechanical Requirements.

1.3 REFERENCES

A. ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.

B. ASTM C177 - Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.

C. ASTM C195 - Mineral Fiber Thermal Insulation Cement.

D. ASTM C335 - Steady-State Heat Transfer Properties of Horizontal Pipe Insulation.

E. ASTM C518 - Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.

F. ASTM C534 - Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.

G. ASTM C552 - Cellular Glass Block and Pipe Thermal Insulation.

H. ASTM C612 - Mineral Fiber Block and Board Thermal Insulation.

I. ASTM C921 - Properties of Jacketing Materials for Thermal Insulation.

J. ASTM D1056 - Flexible Cellular Materials - Sponge or Expanded Rubber.

K. ASTM E84 - Surface Burning Characteristics of Building Materials.

L. ASTM E96 - Water Vapor Transmission of Materials.

1.4 SUBMITTALS

A. Submit under provisions of Section 23 05 00.

B. Product Data: Provide product description, list of materials and thickness for equipment scheduled.

C. Manufacturer's Installation Instructions: Indicate procedures which ensure acceptable workmanship and installation standards will be achieved.

1.5 QUALITY ASSURANCE

A. Materials: Flame spread/smoke developed rating of 25/50 in accordance with ASTM E84.

1.6 QUALIFICATIONS

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

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site as recommended by the manufacturer.

B. Deliver materials to site in original factory packaging, labeled with manufacturer's density and thickness.

C. Store insulation in original wrapping and protect from weather and construction traffic.

D. Protect insulation against dirt, water, chemical, and mechanical damage.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.1 GLASS FIBER, RIGID

A. Insulation: ASTM C612; rigid, noncombustible.
   1. Maximum Thermal Conductivity: ASTM C335, 0.24 per inch at 75 degrees F.
   2. Maximum service temperature: 450 degrees F.
   3. Maximum moisture absorption: 5.0 percent by weight.
   4. Density: 3.0 lb/cu ft.

B. Vapor Barrier Jacket
   1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
   2. Moisture vapor transmission: ASTM E96; 0.04 perm.
   3. Secure with self sealing longitudinal laps and butt strips.
   4. Secure with outward clinch expanding staples and vapor barrier mastic.

C. Facing: 1 inch galvanized steel hexagonal wire mesh stitched on one face of insulation.

D. Vapor Barrier Lap Adhesive
   1. Compatible with insulation.

E. Insulating Cement/Mastic
   1. ASTM C195; hydraulic setting on mineral wool.

2.2 CELLULAR GLASS

A. Insulation: ASTM C552.
   1. Maximum Thermal Conductivity: 0.35 per inch at 75 degrees F.
   2. Density: 8.0 lb/cu ft.

2.3 CELLULAR FOAM

A. Insulation: ASTM C534; flexible, cellular elastomeric, molded or sheet.
   1. Maximum Thermal Conductivity: ASTM C177 or C518; 0.28 per inch at 75 degrees F.
   2. Minimum service temperature: -40 degrees F.
   3. Maximum service temperature: 220 degrees F.
   4. Maximum moisture absorption: ASTM D1056; 1.0 percent (pipe) by volume, 1.0 percent (sheet) by volume.
   5. Moisture vapor transmission: ASTM E96; 0.20 perm inches.
   6. Maximum flame spread: ASTM E84; 25.
   7. Maximum smoke developed: ASTM E84; 50.
   8. Connection: Waterproof vapor barrier adhesive.

B. Elastomeric Foam Adhesive
   1. Air dried, contact adhesive, compatible with insulation.

2.4 JACKETS

A. PVC Plastic
   1. Jacket: ASTM C921, Sheet material, off white color.
      a) Minimum service temperature: -40 degrees F.
      b) Maximum service temperature: 150 degrees
      c) Moisture vapor transmission: ASTM E96; 0.2 perm inches.
      d) Maximum flame spread: ASTM E84; 25.
      e) Maximum smoke developed: ASTM E84; 50.
      f) Thickness: 20 mil.
      g) Connections: Brush on welding adhesive.

   2. Covering Adhesive Mastic
      a) Compatible with insulation.

B. All Service Jacket: UL listed
   1. Fabric: Foil type with reinforcement.
   2. Lagging Adhesive
      a) Compatible with insulation.

C. Aluminum Jacket: ASTM B209.
   1. Thickness: 0.024 inch sheet.
   2. Finish: Smooth.
   3. Joining: Longitudinal slip joints and 2 inch laps.
   4. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

D. Stainless Steel Jacket: Type 316 stainless steel.
   1. Thickness: 0.016 inch.
   2. Finish: Smooth. Corrugated.
   3. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that equipment has been tested before applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

A. Install materials in accordance with manufacturer's instructions.

B. Do not insulate factory insulated equipment.

C. On exposed equipment, locate insulation and cover seams in least visible locations.

D. Finish insulation at supports, protrusions, and interruptions.

E. For exterior applications, cover with aluminum jacket with seams located on bottom side of horizontal equipment.

F. Do not insulate over nameplate or ASME stamps. Bevel and seal insulation around such.

G. Install insulation for equipment requiring access for maintenance, repair, or cleaning, in such a manner that it can be easily removed and replaced without damage.

H. Insulate pumps used for hot service with 2-inch thick preformed rigid glass mineral fiber insulation and pumps used for chilled water service with 2-inch thick cellular glass insulation. Insulate pumps by forming a box around pump housing, drive shaft, and piping. Apply insulation to inside surfaces of 20-gage galvanized sheet-metal boxes having openings for drive shaft and pipes. Construct box by forming bottom and sides using joints which do not leave raw ends of insulation exposed. Band bottom and sides to form a rigid housing that does not rest on pump. Between top cover and sides, fit joints tightly forming a female shiplap joint on side pieces and a male joint on top cover to make top cover removable. Secure insulation to box with adhesive. Allow clearance for draining and adjustment of pump shaft seal.

I. On equipment operating at less than ambient temperature provide vapor barrier.

J. Provide canvas jackets on all inside equipment sized for painting for all cellular glass and rigid glass fiber insulation.

3.3 CELLULAR FOAM

EQUIPMENT	THICKNESS Inch
A. Heating Systems	
Air Separators	3/4"
Expansion Tanks	3/4"
B. Cooling Systems	
Water Storage Tank	1"

Air Separators	1"
Expansion Tanks	1"
Chiller Cold Surfaces (Not Factory Insulated)	1"

3.4 GLASS FIBER, RIGID

EQUIPMENT	THICKNESS Inch
A. Air Handlers (Not Factory Insulated)	1"

END OF SECTION 23 07 16

SECTION 23 07 19 - PIPING INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES (SUBMITTAL REQUIRED FOR EACH ITEM)

A. Piping insulation.

B. Jackets and accessories.

1.2 RELATED SECTION

A. Section 23 05 00 - General Mechanical Requirements

1.3 REFERENCES

A. ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.

B. ASTM C177 - Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.

C. ASTM C518 - Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.

D. ASTM C195 - Mineral Fiber Thermal Insulation Cement.

E. ASTM C335 - Steady-State Heat Transfer Properties of Horizontal Pipe Insulation.

F. ASTM C449 - Mineral Fiber Hydraulic-setting Thermal Insulating and Finishing Cement.

G. ASTM C533 - Calcium Silicate Block and Pipe Thermal Insulation.

H. ASTM C534 - Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.

I. ASTM C547 - Mineral Fiber Preformed Pipe Insulation.

J. ASTM C552 - Cellular Glass Block and Pipe Thermal Insulation.

K. ASTM C640 - Corkboard and Cork Pipe Thermal Insulation.

L. ASTM C921 - Properties of Jacketing Materials for Thermal Insulation.

M. ASTM D1056 - Flexible Cellular Materials - Sponge or Expanded Rubber.

N. ASTM E84 - Surface Burning Characteristics of Building Materials.

O. ASTM E96 - Water Vapor Transmission of Materials.

1.4 SUBMITTALS

A. Submit under provisions of Section 23 05 00.

B. Product Data: Provide product description, list of materials and thickness for each service, and locations.

C. Manufacturer's Installation Instructions: Indicate procedures which ensure acceptable workmanship and installation standards will be achieved.

1.5 QUALITY ASSURANCE

A. Materials: Flame spread/smoke developed rating of 25/50 or less in accordance with ASTM E84.

1.6 QUALIFICATIONS

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

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products to site according to manufacturer's recommendations.

B. Deliver materials to site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

C. Store insulation in original wrapping and protect from weather and construction traffic.

D. Protect insulation against dirt, water, chemical, and mechanical damage.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.1 GLASS FIBER

A. Insulation: ASTM C547; rigid molded, noncombustible.
   1. Maximum Thermal Conductivity: ASTM C335, 0.24 at 75 degrees F.
   2. Minimum Service Temperature: -20 degrees F.
   3. Maximum Service Temperature: 850 degrees F.
   4. Maximum Moisture Absorption: 0.2 percent by volume.

B. Vapor Barrier Jacket
   1. ASTM C921, White kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
   2. Moisture Vapor Transmission: ASTM E96; 0.02 perm inches.
   3. Secure with self sealing longitudinal laps and butt strips.
   4. Secure with outward clinch expanding staples and vapor barrier mastic.

C. Tie Wire: 18 gage stainless steel with twisted ends on maximum 12 inch centers.

D. Vapor Barrier Lap Adhesive
   1. Compatible with insulation.

E. Insulating Cement/Mastic
   1. ASTM C195; hydraulic setting on mineral wool.

F. Fibrous Glass Fabric
   1. Cloth: Untreated; 9 oz/sq yd weight.
   2. Blanket: 1.0 lb/cu ft density.

G. Outdoor Vapor Barrier Mastic
   1. Vinyl emulsion type acrylic, compatible with insulation, white color.

H. Insulating Cement
   1. ASTM C449.

2.2 CELLULAR GLASS

A. Insulation: ASTM C552.
   1. Maximum Thermal Conductivity 0.40 at 75 degrees F.
   2. Maximum Water Vapor Transmission: 0.1 perm.

2.3 CELLULAR FOAM

A. Insulation: ASTM C534; flexible, cellular elastomeric, molded or sheet.
   1. Maximum Thermal Conductivity ASTM C177 or C518; 0.28 at 75 degrees F.
   2. Minimum Service Temperature: -20 degrees F.
   3. Maximum Service Temperature: 220 degrees F.
   4. Maximum Moisture Absorption: ASTM D1056; 1.0 percent (pipe) by volume, 1.0 percent (sheet) by volume.
   5. Moisture Vapor Transmission: ASTM E96; 0.20 perm inches.
   6. Maximum Flame Spread: ASTM E84; 25.
   7. Maximum Smoke Developed: ASTM E84; 50.
   8. Connection: Waterproof vapor barrier adhesive.

B. Elastomeric Foam Adhesive
   1. Air dried, contact adhesive, compatible with insulation.

2.4 JACKETS

A. PVC Plastic
   1. Jacket: ASTM C921, One piece molded type fitting covers and sheet material, off

white color.
a) Minimum Service Temperature: -20 degrees F.
b) Maximum Service Temperature: 150 degrees F.
c) Moisture Vapor Transmission: ASTM E96; 0.5 perm inches.
d) Maximum Flame Spread: ASTM E84; 25.
e) Maximum Smoke Developed: ASTM E84; 50.
f) Thickness: 20 mil.
g) Connections: Brush on welding adhesive.

2. Covering Adhesive Mastic
a) Compatible with insulation.

B. All Service Jacket: UL listed
1. Fabric: Foil type with reinforcement.
2. Lagging Adhesive
a) Compatible with insulation.

C. Aluminum Jacket: ASTM B209.
1. Thickness: 0.020 inch sheet.
2. Finish: Smooth.
3. Joining: Longitudinal slip joints and 2 inch laps.
4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that piping has been tested before applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

A. Install materials in accordance with manufacturer's instructions.

B. On exposed piping, locate insulation and cover seams in least visible locations.

C. Insulated dual temperature pipes or cold pipes conveying fluids below ambient temperature:
1. Provide vapor barrier jackets, factory applied or field applied.
2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe.
3. PVC fitting covers may be used.
4. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.
5. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.

D. For insulated pipes conveying fluids above ambient temperature:
   1. Provide standard jackets, with or without vapor barrier, factory applied or field applied.
   2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe.
   3. PVC fitting covers may be used.
   4. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
   5. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at equipment.

E. Inserts and Shields:
   1. Application: Piping 2 inches diameter or larger.
   2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
   3. Insert Location: Between support shield and piping and under the finish jacket.
   4. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
   5. Insert Material: ASTM C640 cork, hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.

F. Finish insulation at supports, protrusions, and interruptions.

G. For pipe exposed in mechanical equipment rooms or in finished spaces below 10 feet above finished floor, finish with all service jacket prepared for finish painting.

H. For exterior applications, provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

I. For heat traced piping, insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

3.3 PIPING INSULATION THICKNESS

		Tube And Pipe Size (Inches)				
Service	**Material**	**1/4-1 1/4**	**1 ½-3**	**3 ½-5**	**6-10**	**11-36**
Chilled Water Supply & Return Piping (40EF Nominal)	**Cellular Glass**	**1.5**	**2.0**	**2.0**	**2.0**	**3.0**
Hot Domestic Water Supply and Recirculating Piping (Maximum 200EF)	**Glass Fiber**	**1**	**1**	**1.5**	**1.5**	**1.5**
	Cellular Glass	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Cold Domestic Water Piping Above & below Ceilings	**Glass Fiber**	**0.75**	**1**	**1**	**1**	**1**
	Cellular Glass	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
	Flexible cellular	**0.5**	**0.5**	**0.5**	**N/A**	**N/A**
Heating Hot Water (Supply & Return , Maximum 250EF)	**Glass Fiber**	**1.5**	**1.5**	**2**	**2.5**	**3**
	Cellular Glass	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Refrigerant Piping (35EF nominal)	**Flexible cellular**	**0.5**	**N/A**	**N/A**	**N/A**	**N/A**
	Cellular Glass	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
A/C condensate Drain Located Inside Bldg.	**Cellular Glass**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
	Flexible cellular	**0.5**	**0.5**	**0.5**	**N/A**	**N/A**

END OF SECTION 23 07 19

SECTION 23 21 13 - HYDRONIC PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES (SUBMITTAL REQUIRED FOR EACH ITEM)

A. Pipe and pipe fittings for:
   1. Chilled water piping system.
   2. Equipment drains and overflows.

B. Valves:
   1. Gate valves.
   2. Ball valves.
   3. Plug valves.
   4. Check valves.

1.2 RELATED SECTIONS

A. Section 23 05 00 - Mechanical General Requirements.

1.3 REFERENCES

A. ASME - Boiler and Pressure Vessel Codes, SEC 9 - Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brasing Operators.

B. ASME B16.3 - Malleable Iron Threaded Fittings Class 50 and 300.

C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.

D. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

E. ASME B31.9 - Building Services Piping.

F. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.

G. ASTM A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.

H. ASTM B32 - Solder Metal.

I. ASTM B88 - Seamless Copper Water Tube.

J. ASTM D1785 - Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

K. ASTM D2241 - Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR-Series).

L. ASTM D2466 - Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.

M. ASTM D2467 - Socket-Type Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.

N. ASTM D2855 - Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.

O. AWS D1.1 - Structural Welding Code.

P. AWWA C105 - Polyethylene Encasement for Ductile Iron Piping for Water and Other Liquids.

Q. AWWA C110 - Ductile - Iron and Grey -Iron Fittings 3 in. through 48 in., for Water and Other Liquids.

R. AWWA C111 - Rubber-Gasket Joints for Ductile Iron and Grey-Iron Pressure Pipe and Fittings.

S. AWWA C151 - Ductile-Iron Pipe,Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.

T. MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacture.

U. MSS SP69 - Pipe Hangers and Supports - Selection and Application.

V. MSS SP72 - Ball Valves with Flanged or Butt-welding Ends for General Service.

W. MSS SP80 - Bronze Gate, Globe, Angle and Check Valves.

X. MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

1.4 SUBMITTALS

A. Submit under provisions of Section 23 05 00.

B. Product Data: Include data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.

C. Welders Certificate: Include welders certification of compliance with ASME SEC 9. Submit copies of the welding procedure specifications and procedure qualification test

results for each type of welding required. Submit this information on the forms printed in ASME BPVC SEC IX or their equivalent. Submit welders or welding operators names, together with certification of what the individual is performance qualified to perform. The certification shall state the type of welding and positions for which each is qualified, date qualified, and the firm and individual certifying the qualification tests.

D. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

1.5 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 23 05 00.

B. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.6 QUALIFICATIONS

A. Manufacturer: Companies specializing in manufacturing the Products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing the work of this section with minimum three years documented experience.

C. Welders: Certify in accordance with ASME SEC 9. The Welder shall have been certified within the last 12 months and welded continuously since being certified.

1.7 REGULATORY REQUIREMENTS

A. Conform to ASME B31.9 code for installation of piping system.

B. Welding Materials and Procedures: Conform to ASME SEC 9.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products delivered to site according to manufacturer's recommendations.

B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

C. Provide temporary protective coating on cast iron and steel valves.

D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Do not install underground piping when bedding is wet or frozen.

PART 2 PRODUCTS

2.2 CHILLED WATER PIPING, BURIED

A. Steel Pipe: ASTM A53, Schedule 40, 0.375 inch wall for sizes 12 inch and over, black with AWWA C105 polyethylene jacket, or double layer, half-lapped 10 mil polyethylene tape.
   1. Fittings: ASTM A234, forged steel welding type with double layer, half-lapped 10 mil polyethylene tape.
   2. Joints: AWS D1.1, welded.
   3. The piping shall be threaded or welded 2", above 2" shall be welded.

B. Copper Tubing: ASTM B88, Type K, annealed.
   1. Fittings: ASME B16.22, wrought copper.
   2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F.

B. Ductile Iron Pipe: AWWA C151.
   1. Fittings: AWWA C110, ductile iron, standard thickness.
   2. Joints: AWWA C111, rubber gasket with 3/4 inch diameter rods.

C. PVC Pipe: ASTM D1785, Schedule 40, and Schedule 80 for sizes 8 inch and larger, or ASTM D2241, SDR 21 or 26.
   1. Fittings: ASTM D2466, or ASTM D2467, PVC.
   2. Joints: ASTM D2855, solvent weld.

2.3 CHILLED, ABOVE GRADE

A. Steel Pipe: ASTM A53, Schedule 40, 0.375 inch wall for sizes 12 inch and over, black.
   1. Fittings: ASME B16.3, malleable iron or ASTM A234, forged steel welding type.
   2. Joints: Threaded or AWS D1.1 welded.
   3. The piping shall be threaded or welded up to 2", above 2" shall be welded.

B. Copper Tubing: ASTM B88, Type L, hard drawn.
   1. Fittings: ASME B16.18, cast brass, or ASME B16.22, solder wrought copper.

2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F.

2.4 EQUIPMENT DRAINS AND OVERFLOWS

A. Steel Pipe: ASTM A53, Schedule 40 galvanized.
1. Fittings: Galvanized cast iron, or ASME B16.3 malleable iron.
2. Joints: Threaded, or grooved mechanical couplings.

B. Copper Tubing: ASTM B88, Type L, hard drawn.
1. Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F.

C. PVC Pipe: ASTM D1785, Schedule 40, and Schedule 80 for sizes 8 inch and larger, or ASTM D2241, SDR 21 or 26.
1. Fittings: ASTM D2466 or D2467, PVC.
2. Joints: ASTM D2855, solvent weld.

2.5 PIPE HANGERS AND SUPPORTS

A. Conform to MSS SP58, MSS SP69 and MSS SP89.

B. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Type-6, Malleable iron, adjustable swivel, split ring.

C. Hangers for Cold Pipe Sizes 2 Inches and Over: Type-1, Carbon steel, adjustable, clevis.

D. Hangers for Hot Pipe Sizes 2 to 4 Inches: Type-1, Carbon steel, adjustable, clevis.

E. Hangers for Hot Pipe Sizes 6 Inches and Over: Adjustable steel yoke, cast iron roll, double hanger.

F. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

G. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.

H. Wall Support for Pipe Sizes 4 Inches and Over: Type-33, Welded steel bracket and wrought steel clamp.

I. Vertical Support: Type-42, Steel riser clamp.

J. Floor Support for Cold Pipe: Type-37, Cast iron adjustable pipe saddle, lock nut,

nipple, floor flange, and concrete pier or steel support.

K. Copper Pipe Support: Type-6, Carbon steel ring, adjustable, copper plated.

L. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

M. Inserts: Type-18, Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.6 UNIONS, FLANGES, AND COUPLINGS

A. Unions for Pipe 2 Inches and Under:
1. Ferrous Piping: 150 psig malleable iron, threaded.
2. Copper Pipe: Bronze, soldered joints.

B. Flanges for Pipe Over 2 Inches:
1. Ferrous Piping: 150 psig forged steel, slip-on.
2. Copper Piping: Bronze.
3. Gaskets: 1/16 inch thick preformed neoprene.

C. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.7 GATE VALVES

A. Up To and Including 2 Inches:
1. Bronze body, bronze trim, union bonnet, rising stem, handwheel, inside screw with backseating stem, solid wedge disc, solder or threaded ends, MSS SP-80.

B. Over 2 Inches:
1. Iron body, bronze trim, bolted bonnet, rising stem, handwheel, outside screw and yoke, solid wedge disc with bronze seat rings, flanged ends, AMSE B16.34.

2.8 BALL VALVES

A. Up To and Including 2 Inches:
1. Bronze two piece body, stainless steel ball, teflon seats and stuffing box ring, lever handle, solder or threaded ends.

B. Over 2 Inches:
1. Cast steel body, chrome plated steel ball, teflon seat and stuffing box seals, lever handle, or gear drive handwheel for sizes 10 inches and over, flanged, MSS SP-72.

2.9 BUTTERFLY VALVES

A. Over 3 Inches:
   1. Valve body shall be constructed of ASTM-A126, Class B cast iron with flanged ends. Flanges shall be fully faced and drilled in accordance with ANSI Standards B16.1, Class 125.
   2. Rubber body seats shall be of one piece construction, simultaneously molded and bonded into a recessed cavity in the valve body protecting the leading edge of the seat from shearing force of the line of flow. Seats may not be located on the disc or be retained by segments and/or screws. For wafer style valves, the seat shall cover the entire inner surface of the valve body and extend over the outside face of the valve body to form a flange gasket.
   3. Valve bearings shall be self-lubricating, non-mettalic material to effectively isolate the disc-shaft assembly from the valve body. Metal to metal thrust bearings in the flow stream are not allowed.
   4. The disc shall be an on-center, lens shaped design to afford minimal pressure drop and line turbulence. Disc material shall be ASTM A126, Class B cast iron and a stainless steel type 316 edge with a minimum width equal to the width of the disc edge. The disc shall be retained by stainless steel pin, extending through the full diameter of the shaft to withstand the specified line pressure up to valve rating and the torque required to operate the valve. Disc stops located in the flow stream are not allowed.
   5. Valve shaft shall be stainless steel type 304. At the operator end of the valve shaft, a packing gland utilizing “V” type chevron packing shall be utilized. “O” ring and “U” cup packings shall not be allowed.
   6. Operator: Provide each Butterfly valve with a counter clockwise opening manual operator with position indicator sized for bi-directional flow and 450 ft.-lb. of torque. A vent shall be provided between the valve trunnion and actuator base to prevent infiltration of fluid into the actuator.

2.10 SWING CHECK VALVES

A. Up To and Including 2 Inches:
   1. Bronze body, bronze trim, bronze rotating swing disc, with composition disc, solder or threaded ends.

B. Over 2 Inches:
   1. Iron body, bronze trim, bronze or bronze faced rotating swing disc, renewable disc and seat, flanged ends.

2.11 SPRING LOADED CHECK VALVES

A. Iron body, bronze trim, split plate, hinged with stainless steel spring, resilient seal

bonded to body.

PART 3 EXECUTION

3.1 SYSTEM DESCRIPTION

A. Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Flanges, union, and couplings for servicing shall be provided.

B. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.

C. Use non-conducting dielectric connections whenever jointing dissimilar metals in open systems.

D. Provide pipe hangers and supports in accordance with MSS SP69 unless indicated otherwise.

E. Use gate, ball or as indicated valves for shut-off and to isolate equipment, part of systems, or vertical risers.

F. Use plug cocks for throttling service when calibrated valves are not required for balancing. Use non-lubricated plug cocks only when shut-off or isolating valves are also provided.

G. Use 3/4 inch ball valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment.

3.2 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install heating water, chilled water, condenser water, piping to ASME B31.9.

C. Route piping in orderly manner, parallel to building structure, and maintain gradient.

D. Install piping to conserve building space, and not interfere with use of space.

E. Group piping whenever practical at common elevations.

F. Sleeve all pipe passing through partitions, walls and floors.

G. Slope piping and provide for drain at low points.

H. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

I. Inserts:
   1. Provide inserts for placement in concrete formwork.
   2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
   3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
   4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
   5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above recessed into and grouted flush with slab.

J. Pipe Hangers and Supports:
   1. Install in accordance with MSS SP89 or more stringent if required by specifications.
   2. Support horizontal piping as scheduled.
   3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
   4. Place hangers within 12 inches of each horizontal elbow. Hangars shall be placed adjacent to valves, strainers and other appurtenances in such a manner to support the load concentrations and to support the piping in the event components are removed during maintenance. Final arrangement and number of hangars will be as directed by the contracting officer.
   5. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
   6. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.

7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
8. Provide copper plated hangers and supports for copper piping.
9. All exposed steel hangers and supports shall be painted with a prime cost then a finish coat with the color to match existing walls. Hangers and supports located in crawl spaces, pipe shafts, and above suspended ceiling spaces are not considered exposed.

K. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

L. Provide access doors or panels any place valves are installed behind hard ceiling or walls.

M. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.

N. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.

O. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting.

P. Install valves with stems upright or horizontal, not inverted.

Q. The piping system shall be flushed before being connected to the existing system. The flushing shall be performed at water velocities above 12 feet per second before the equipment is connected. Bypass piping shall be provided as required. The system shall be flushed untill the discharge is completely clear.

R. The piping systems shall be tested at 1 ½ times the working pressure or 100 PSI which ever is higher. The system shall maintain the pressure for a minimum of 8 hours without any drop in pressure. After testing all gauges and equipment to do pressure test shall be removed and system checked for leaks at system pressure.

S. The piping system shall be chemically cleaned then flushed and then the operating chemical treatment provided as part of this contract.

3.4 SCHEDULES

A. Pipe Hanger Spacing.

1. Steel and copper shall be according to MSS SP-69.

2.

PVC PIPE SIZE Inches	HANGER ROD MAX. HANGER SPACING Feet
1/2 to 1-1/4	4.0
1-1/2 to 2	4.5
2-1/2 to 3	5.5
4 to 6	6.0
8 and over	8.0

3. HANGER ROD DIAMETER

For 3/4" Thur 4"pipes 3/8" Rod
For 5" Thur 8"pipes ½" Rod
For 10" Thur 12"pipes 5/8" Rod
For 12" Thur 18"pipes 3/4" Rod

END OF SECTION 23 21 13

SECTION 23 21 16 - HYDRONIC SPECIALTIES

PART 1 GENERAL

1.1 SECTION INCLUDES (SUBMITTAL REQUIRED FOR EACH ITEM)

A. Air vents.

B. Strainers.

C. Relief valves.

1.2 RELATED SECTIONS

A. Section 23 05 00 - Mechanical General Requirements.

1.3 SUBMITTALS

A. Submit under provisions of Section 23 05 00.

B. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description, model and dimensions.

C. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

1.4 REFERENCES

A. ASME - Boilers and Pressure Vessel Codes, SEC 8-D-Rules for Construction of Pressure Vessels.

1.5 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 23 05 00.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 23 05 00.

B. Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site according to good construction practices and to prevent damage and deterioration.

B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

C. Provide temporary protective coating on cast iron and steel valves.

D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work then capping, and isolating parts of the completed system from that under construction.

PART 2 PRODUCTS

2.1 AIR VENTS

A. Manual Type: Short vertical sections of 2 inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.

B. Float Type: Brass or stainless steel body, copper, polypropylene, or stainless float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.

2.2 STRAINERS

A. Size 2 inch and Under:

1. Screwed brass or iron body for 175 psig working pressure, Y pattern with 3/32 inch stainless steel perforated screen.

B. Size 2-1/2 inch to 4 inch:

1. Flanged iron body for 175 psig working pressure, Y pattern with 1/8 inch stainless

steel perforated screen.

C. Size 5 inch and Larger:

1. Flanged iron body for 175 psig working pressure, basket pattern with 1/8 inch stainless steel perforated screen.

2.3 RELIEF VALVES

A. Bronze body, Teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labeled.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install specialties in accordance with manufacturer's instructions.

B. Provide automatic air vents at system high points and as indicated.

C. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.

D. Provide valved drain and hose connection on strainer blow down connection.

J. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.

L. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

END OF SECTION 23 21 16

SECTION 23 64 10

AIR COOLED WATER CHILLERS

PART 1 GENERAL

1.1 SECTION INCLUDES (SUBMITTAL IS REQUIRED FOR EACH ITEM)

A. Chiller package.

B. Controls and control connections.

C. Chilled water connections.

D. Starters.

1.2 RELATED SECTIONS

A. Section 23 05 00 - Mechanical General Requirements.

1.3 SUBMITTALS

A. Submit under provisions of Section 23 05 00 - Mechanical General Requirements.

B. Submit shop drawings indicating components, assembly, dimensions, weights and loadings, required clearances, and location and size of field connections. Indicate valves, strainers, and valves required for complete system.

C. Submit product data indicating rated capacities, weights, specialties and accessories, electrical requirements and wiring diagrams.

D. Submit written certification that components of package not furnished by manufacturer have been selected in accordance with manufacturers requirements.

E. Submit manufacturer's installation instructions.

1.4 REFERENCES

A. ANSI/ARI 550 - Rating Centrifugal and Rotary Chillers.

B. ANSI/ARI 590 - Reciprocating Water - Chilling Packages.

C. ANSI/ASHRAE 15 - Safety Code for Mechanical Refrigeration.

D. ANSI/ASME SEC 8 - Boiler and Pressure Vessel Code

E. ANSI/UL 465 - Central Cooling Air Conditioners.

1.5 OPERATION AND MAINTENANCE DATA

A. Submit operations data under provisions of Section 23 05 00 Mechanical General Requirements.

B. Include start-up instructions, maintenance data, parts lists, controls, and accessories. Include trouble- shooting guide.

1.6 REGULATORY REQUIREMENTS

A. Conform to ANSI/ARI 590 code for testing and rating of reciprocating water chillers or ANSI/ARI Standard for rating centrifugal and rotary chillers.

B. Conform to ANSI/UL 465 code for construction of water chillers and provide UL/ETL label.

C. Conform to ANSI/ASME SEC 8 Boiler and Pressure Vessel Code for construction and testing of reciprocating water chillers.

D. Conform to ANSI/ASHRAE 15 code for construction and operation of reciprocating water chillers.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store and protect products according to good construction practices.

B. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

C. Protect units on site from physical damage.

1.8 WARRANTY

A. Provide five year warranty for compressor including parts and labor.

B. Warranty: Provide a manufacturer's full parts and labor warranty for one year from the date of substantial completion of the project.

1.9 MAINTENANCE SERVICE

A. Furnish service and maintenance of complete assembly for one year from Date of Substantial Completion.

PART 2 PRODUCTS

2.1 GENERAL UNIT DESCRIPTION

A. Provide factory assembled and tested outdoor air cooled liquid chillers consisting of compressors, condenser, evaporator, expansion valve, refrigeration accessories, starter, and control panel. Construction and ratings shall be in accordance with ANSI/ARI 550 or ANSI/ARI 590 Standards.

2.2 COMPRESSORS

A. Construct compressors with heat treated forged steel or ductile iron shafts, aluminum alloy connecting rods, automotive type pistons, rings to prevent gas leakage, discharge valves, and sealing surface immersed in oil. Rotors shall be of high grade steel alloy.

B. Statically and dynamically balance rotating parts.

C. Provide oil lubrication system with centrifugal oil pump, oil level sight glass, oil charging valve and oil filter to ensure adequate lubrication during starting, stopping, and normal operation.

D. Provide two or more hermetic direct drive scroll compressors with automatic capacity reduction equipment consisting of compressor start/stop or unloading. Compressor must start unloaded for soft start on motors.

E. Provide constant speed 1800 or 3600 rpm compressor motor, suction gas cooled with solid state sensor and electronic winding overheating protection, designed for across-the- line or star delta starting. Furnish with starter and integral disconnect. Compressor motor power factor shall be .90 or greater. If the compressor motor power factor is less than .90, power factor correction capacitors must be installed.

F. Provide crankcase heater to evaporate refrigerant returning to crankcase during shut down. Energize heater when compressor is not operating.

2.3 EVAPORATOR

A. Provide braze plate heat exchanger made of stainless steel with copper as the braze material.

B. Design, test, and stamp refrigerant side for 430 psig working pressure and water side for 215 psig working pressure, in accordance with ANSI/ASME SEC 8.

C. Insulate with 0.75 inch minimum thick flexible elastometric rubber closed cell insulation with maximum K value of 0.28. Provide heat tape to protect evaporator to -20 degrees F.

D. Provide low point water drain connection, vent and fittings for factory installed leaving water temperature control and low temperature cutout sensors.

E. Evaporator shall have only one entering and one leaving connection.

F. Provide with heat tracing.

2.4 CONDENSER AND FANS

A. Construct condenser coils of aluminum fins mechanically bonded to internally finned copper tubing. Provide sub-cooling circuits. Condenser shall be factory proof and leak tested at 715 psig.

B. Provide vertical discharge direct driven propeller type condenser fans with fan guard on discharge. Entire fan assembly shall be statically and dynamically balanced and fan assembly shall be either painted or zinc coated steel. Fan guard shall be either PVC, chrome or zinc coated.

C. Provide louvered factory guard panels. Guards shall cover condenser, evaporator and compressor sections so all are covered.

D. Provide fan motors with permanently lubricated ball bearings and built-in thermal overload protection.

E. Condenser coils shall be provided from the factory with protective coating designed specifically for coastal installation. Protective coating shall be an epoxy polymer applied using an electrostatic charge to provide a uniform coating throughout the entire condenser coil.

2.5 ENCLOSURES

A. House components in galvanized steel frame and mounted on welded structural steel base. Hot-dip galvanized steel frame coating shall be Underwriters Laboratories Inc. (UL) recognized as G90-U.

B. Unit panels, decorative louvered panels, and control panels shall be finished with a baked on powder paint. Control panel doors shall have door stays. Paint system shall meet the requirements for outdoor equipment. All doors shall be lockable.

C. Mount starters and disconnects in weatherproof panel provided with full opening access doors. Provide means to lock disconnect.

D. Casings fabricated from steel that do not have a Zinc coating conforming to ASTM A 123 or ASTM A525 shall be treated for the prevention of corrosion with a factory coating or paint system. The coating or paint system shall withstand 500 hours in a salt-spray fog test in accordance with ASTM B 117. Each specimen shall have a standard scribe mark as defined in ASTM D 1654. Upon completion of exposure, the coating or paint system shall be evaluated and rated in accordance with procedures A and B of ASTM D 1654. The rating of failure at the scribe mark shall be not less than six (average creepage not greater than 1/8 inch). The rating of the unscribed area shall not be less than ten (no failure). Thickness of coating or paint system on the actual equipment shall be identical to that on the test specimens with respect to materials, conditions of application, and dry-film thickness.

2.6 REFRIGERANT CIRCUIT

A. All units shall have compressors as indicated.

B. Provide for each refrigerant circuit:
1. Liquid line shutoff valve.
2. Filter dryer (replaceable core type).
3. Liquid line sight glass and moisture indicator.
4. Electronic or thermal expansion valve sized for maximum operating pressure.
5. Charging valve.
6. Discharge and oil line check valves.
7. Compressor suction and discharge service valves.
8. High side pressure relief valve.
9. Full operating charge of R-22 and oil.
10. Unit factory leak tested at 200 psig.

2.7 CONTROLS

A. On chiller, mount weatherproof control panel, containing starters, power and control wiring, molded case disconnect switch (UL approved) with external lockable operator handle, factory wired with terminal block power connection. Provide single point power connection on units with MCA less than 500 amps. Provide primary and secondary fused control power transformer and a single 115 volt single phase connection for evaporator heat tape.

B. Provide the following safety controls with indicating lights or diagnostic readouts.

1. Low chilled water temperature protection.
2. High refrigerant pressure.

3. Low oil flow protection.
4. Loss of chilled water flow.
5. Contact for remote emergency shut-down.
6. Loss of refrigerant charge protection.
7. Motor current overload.
8. Phase reversal/unbalance/single phasing.
9. Over/under voltage.
10. Failure of water temperature sensor used by controller.
11. Compressor status (on or off).

C. Provide the following operating controls:

1. Stepped leaving chilled water temperature controller which activates loading as indicated.

2. Five minute solid state anti-recycle timer to prevent compressor from short cycling.

3. Low ambient controls for operation down to 25 degrees F or lower.

4. Compressor current sensing unloader unit that unloads compressors to help prevent current overload nuisance tripouts.

5. Auto lead-lag functions that constantly evens out running hours and compressor starts automatically. If contractor can not provide this function then cycle counter and hour meter shall be provided so owner can be instructed by the contractor on how to manually change lead lag on compressors and even out compressor starts and running hours.

6. Low ambient lockout control with adjustable setpoint.

7. Condenser fan sequencing which automatically cycles fans in response to ambient, condensing pressure and expansion valve pressure differential thereby optimizing unit efficiency.

D. Provide pre-piped gauge board with pressure gauges for suction and discharge refrigerant pressures or digital display of pressures on microprocessor.

E. Provide ammeters for each compressor or digital display of % RLA on microprocessor.

2.8 BUILDING MANAGEMENT SYSTEM INTERFACE

A. The chiller shall have the ability to accept a 4-20 mA control signal from building automation system for leaving water temperature and demand limiting setpoint

adjustment. Provide chiller with Trane Tracer Summit system interface. This shall not require additional software or hardware not provided on unit.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Align chiller package on steel beams and/or concrete foundations as indicated.

C. Connect to electrical service.

D. Connect to chilled water piping. On inlet, provide thermometer well for temperature controller and other items as indicated on drawings.

E. Arrange piping for easy dismantling to permit tube cleaning.

F. The manufacturer shall coordinate with the controls contractor and provide interface devices required to interface with the building control system.

G. Provide heat trace on evaporator.

3.2 MANUFACTURER'S FIELD SERVICES

A. Prepare and start systems.

B. Supply service of factory trained representative for a period of one day to supervise testing, dehydration and charging of machine, start-up, and instruction on operation and maintenance to Owner.

C. Supply initial charge of refrigerant and oil.

END OF SECTION

SECTION 26 05 00 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals:

1. Product Data: Panelboards.

PART 2 - PRODUCTS

2.1 RACEWAYS

A. Raceways:

1. EMT: ANSI C80.3, zinc-coated steel, with set-screw or compression fittings.
2. ENT: NEMA TC 13, complying with UL 1653.
3. FMC: Zinc-coated steel.
4. IMC: ANSI C80.6, zinc-coated steel, with threaded fittings.
5. LFMC: Zinc-coated, flexible steel with sunlight-resistant and mineral-oil-resistant plastic jacket.
6. RNC: NEMA TC 2, with NEMA TC3 fittings.
7. Raceway Fittings: Specifically designed for raceway type used in Project.

B. Surface Raceways:

1. Metal: Galvanized steel with snap-on covers.
2. Plastic: PVC, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.

2.2 CONDUCTORS AND CABLES

A. Conductors:

1. Conductors, No. 10 AWG and Smaller: Solid or stranded copper.
2. Conductors, Larger Than No. 10 AWG: Stranded copper.
3. Insulation: Thermoplastic, rated at 75 deg C minimum.
4. Wire Connectors and Splices: Units of size, ampacity rating, material, type, and class suitable for service indicated.

2.3 GROUNDING MATERIALS

A. Conductors: Solid for No. 8 AWG and smaller, and stranded for No. 6 AWG and larger unless otherwise indicated.

1. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
2. Bare, Solid-Copper Conductors: Comply with ASTM B 3.
3. Bare, Stranded-Copper Conductors: Comply with ASTM B 8.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts with clamp-type pipe connectors sized for pipe.

2.4 ELECTRICAL IDENTIFICATION MATERIALS

A. Conductor Identification Materials: Color-Coding Conductor Tape: Self-adhesive vinyl tape 1 to 2 inches (25 to 50 mm) wide.

B. Tape Markers for Wire: Vinyl or vinyl-cloth, self-adhesive, wraparound type with circuit identification legend machine printed by thermal transfer or equivalent process.

C. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

D. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1.0-mm) galvanized-steel backing; and with colors, legend, and size required for application.

E. Equipment Identification Labels: Engraved, laminated acrylic or melamine label; punched or drilled for screw mounting. White letters on a dark-gray background; red letters for emergency systems.

F. Fasteners: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

2.5 SLEEVES FOR RACEWAYS AND CABLES

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.

C. Sleeves for Rectangular Openings: Galvanized-steel sheet.

D. Sleeve Seals: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

PART 3 EXECUTION

3.1 GENERAL ELECTRICAL EQUIPMENT INSTALLATION REQUIREMENTS

A. Install electrical equipment to allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.

B. Install electrical equipment to provide for ease of disconnecting the equipment with minimum interference to other installations.

C. Install electrical equipment to allow right of way for piping and conduit installed at required slope.

D. Install electrical equipment to ensure that connecting raceways, cables, wireways, cable trays, and busways are clear of obstructions and of the working and access space of other equipment.

E. Install required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

F. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Comply with requirements in Division 08 Section "Access Doors and Frames."

G. Install sleeve and sleeve seals of type and number required for sealing electrical service penetrations of exterior walls.

H. Comply with NECA 1.

3.2 RACEWAY AND CABLE INSTALLATION

A. Outdoor Raceways Applications:

1. Exposed or Concealed: IMC.
2. Underground, Single Run: RNC.
3. Connection to Vibrating Equipment: LFMC.
4. Boxes and Enclosures: Metallic, NEMA 250, Type 3R or Type 4.

B. Indoor Raceways Applications:

1. Exposed or Concealed: EMT.

2. Connection to Vibrating Equipment: FMC; in wet or damp locations, use LFMC.
3. Damp or Wet Locations: IMC.
4. Boxes and Enclosures: Metallic, NEMA 250, Type 1, unless otherwise indicated.

C. Conceal raceways and cables, unless otherwise indicated, within finished walls, ceilings, and floors.

D. Install raceways and cables at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Locate horizontal raceway runs above water and steam piping.

E. Install pull wires in empty raceways.

F. Connect motors and equipment subject to vibration, noise transmission, or movement with a 72-inch (1830-mm) maximum length of flexible conduit.

G. Install raceways and cables conceal within finished walls, ceilings, and floors unless otherwise indicated.

H. Install raceways and cables at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Locate horizontal raceway runs above water and steam piping.

3.3 WIRING METHODS

A. Feeders and Branch Circuits Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-THWN, single conductors in raceway.

3.4 IDENTIFICATION

A. Equipment Identification Labels:

1. Labeling Instructions:

a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where 2 lines of text are required, use labels 2 inches (50 mm) high.
b. Elevated Components: Increase sizes of labels and legend to those appropriate for viewing from the floor.

2. Equipment to Be Labeled:

a. Panelboards, electrical cabinets, and enclosures.
b. Electrical switchgear and switchboards.

c. Disconnect switches.

B. Verify identity of each item before installing identification products.

C. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

D. Attach nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.

E. Install system identification color banding for raceways and cables at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.

3.5 SLEEVE AND SLEEVE SEALS INSTALLATION

A. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

B. Cut sleeves to length for mounting flush with both wall surfaces.

3.6 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Comply with requirements in Division 07 Section "Penetration Firestopping."

END OF SECTION 26 05 00

SECTION 26 24 16 - PANELBOARDS

PART 1 GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals:

1. Product data for panelboards and overcurrent protective devices.

B. Comply with NEMA PB 1.

C. Comply with NFPA 70.

PART 2 PRODUCTS

2.1 MANUACTURED UNITS

A. Surface-mounted, NEMA PB 1, Type 1.

1. Front: Secured to box with concealed trim clamps.
2. Doors: With concealed hinges, flush catches, and tumbler locks, all keyed alike.
3. Bus: Hard-drawn copper, 98 percent conductivity for each phase, neutral, and ground.
4. Main and Neutral Lugs: Type suitable for use with conductor material.
5. Equipment Ground Bus: Bonded to box.
6. Feed-through Lugs: Type suitable for use with conductor material.

B. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

C. Panelboard Short-Circuit Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 LIGHTING AND APPLIANCE PANELBOARDS

A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers.

2.3 DISTRIBUTION PANELBOARDS

A. Doors: Omit in fused-switch panelboards.

B. Main Overcurrent Protective Devices: Circuit breaker.

C. Branch overcurrent protective devices shall be one of the following:

1. For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on type.
2. For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.4 COMPONENTS

A. Molded-Case Circuit Breaker: NEMA AB 1 thermal-magnetic type; UL 489 with interrupting capacity to meet available fault currents.

1. Appropriate for application; Type SWD for switching; Type HACR for heating, air-conditioning, and refrigerating equipment loads.
2. GFCI Circuit Breakers: Single- and two-pole type with [5] [30]-mA trip sensitivity.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install panelboards and accessory items according to NEMA PB 1.1. Indicate installed circuit loads on a typed circuit directory after balancing panelboard loads.

B. Arrange conductors into groups; bundle and wrap with wire ties.

END OF SECTION 262416