**PART 1 – GENERAL**

* 1. **SUMMARY**

1. Section Includes: Above ground piping systems for heating, ventilating, and air conditioning systems. Systems include but are not limited to the following:
2. Chilled Water System.
3. Condenser Water.
4. Hot Water Heating System.
5. Low-pressure Steam.
6. Miscellaneous Piping Required for Equipment of this Section.
7. Connections to Exterior Utilities.
8. Related Requirements:
9. Division 01: General Requirements.
10. Section 23 0500: Common Work Results for HVAC.
11. Section 23 0513: Basic HVAC Materials and Methods.
12. Section 23 0553: HVAC Identification.
13. Section 23 0700: HVAC Insulation.
14. Section 23 0900: HVAC Instrumentation and Controls.
15. Section 23 2016: Underground HVAC Piping.
16. Section 23 2500: HVAC Water Treatment.
17. Section 23 6416: Oil Lubricated Centrifugal Water Chillers.
18. Section 23 6423: Scroll Water Chillers.
19. Section 23 6426: Rotary-Screw Water Chillers.
20. Section 23 6428: Air-Cooled Rotary Screw Chillers.
21. Section 23 6500: Cooling Towers.
22. Section 31 2323: Excavation and Fill for Utilities.
23. Section 23 9000: HVAC Sound, Vibration and Seismic Control.
    1. **REFERENCES**
24. ASTM International:
25. ASTM A47 – Standard Specification for Ferritic Malleable Iron Castings.
26. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
27. ASTM A105 - Standard Specification for Carbon Steel Forgings for Piping Applications.
28. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
29. ASTM A181 - Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.
30. ASTM A234 - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
31. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60000 PSI Tensile Strength.
32. ASTM B32 - Standard Specification for Solder Metal.
33. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.
34. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
35. American National Standard Institute (ANSI) and The American Society for Mechanical Engineers (ASME):
36. ANSI/ASME B1.20.1 - Pipe Threads, General Purpose, Inch.
37. ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
38. ANSI/ASME B16.9 - Factory Made Wrought Butt-welding Fittings.
39. ANSI/ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
    1. **SUBMITTALS**
    2. Provide submittals in accordance with Division 01, Sections 23 0500, Common Work Results for HVAC, and 23 0513, Basic HVAC Materials and Methods.
    3. Provide Shop Drawings with dimensioned piping layout and details of expansion loops, elbows, anchor points, pipe supports, building entry points and other pertinent information required to verify layout. Indicate systems, pipe material and sizes, show location of devices such as pumps, unions, joints, valves, flow measuring devices, fittings, flexible connectors, and location of hangers and supports, intent and type of materials are in accordance with this Section. Prefabricated pipe units shall be dimensioned and numbered to fit actual Work with field verified conditions prior to start of factory fabrication.
    4. Submit manufacturer’s Product Data for products listed on Part 2 of this section, demonstrating conformance to specified standards and specification requirements.
    5. **QUALITY ASSURANCE**
40. Comply with applicable codes and referenced standards: ASTM, ASME/ANSI, CPC (California Plumbing Code), CMC (California Mechanical Code).
41. Qualifications of Manufacturer: Products used in the Work of this Section shall be produced by manufacturers regularly engaged in manufacture of similar items and with a history of successful production.
    1. **DELIVERY, STORAGE AND HANDLING**
    2. Delivery and Storage: Deliver materials to Project site in their original unopened containers with labels intact and legible at time of delivery. Store in strict accordance with manufacturer's recommendations.
    3. **COORDINATION**
    4. Coordinate related and adjacent activities in accordance with Section 01 3113, Project Coordination.

**PART 2 – PRODUCTS**

**2.01 MATERIALS AND EQUIPMENT**

* 1. Low Pressure Steam Systems:
     1. Pipe: ASTM A53 Schedule 40 Type S-seamless Grade B black steel. Pipes and fittings shall be properly marked with schedule number, ASTM number, manufacturer, etcetera, in accordance with ASTM requirements.
     2. Fittings:
  2. 2-inch and smaller: 150 pound standard weight, black, malleable iron, threaded. Material conforms to ASTM A47; threads, ANSI/ASME B1.20.1 malleable iron, threaded.
  3. 2 ½-inch and larger: Standard weight, seamless steel; welding fittings and flanges ASTM A234 and ANSI/ASME B16.9 for fittings and ASTM A181 or ASTM A105 for flanges.
     1. Joints: Refer to Section 23 0513, Basic HVAC Materials and Methods, for threaded pipe joints and welded connections.
     2. Unions on piping 2-inch Diameter and Smaller: 150 pound malleable iron, ground joint pattern, brass to iron seat, ASME B16.39 or ASTM A47, grade 32510, black.
     3. Flanges on Piping 2 ½-inch Diameter and Larger:

1. 150 pound forged steel, weld neck or slip-on, ASTM A181 and ANSI/ASME B16.5. Furnish flat faced flanges against equipment with flat faced flanges.
2. Flange gaskets: Mineral fiber, 1/16 inch thick, equivalent to Garlock Style 9800, Durlon 8300, or equal.
3. Bolting materials: Carbon steel heavy hex bolts and nuts, ASTM A307, type B.
   1. Chilled Water, Heating Hot Water and Condenser Water:
      1. Pipe:
4. 2-inch and smaller: Standard weight, seamless copper, type L hard drawn, ASTM B88.
5. 2 ½-inches and larger: Schedule 40 seamless black steel, ASTM A53, grade B, type S. Pipes and fittings shall be properly marked with schedule number, ASTM number, manufacturer, etcetera, in accordance with ASTM requirements.
   * 1. Fittings:
6. 2-inch and smaller: Wrought solder-type copper, in accordance with ANSI/ASME B16.22.
7. 2 ½-inch and larger:
   1. 150 pound forged steel, weld neck or slip-on, ASTM A181 and ANSI/ASME B16.5. Furnish flat faced flanges against equipment with flat faced flanges.
   2. Flange gaskets: Mineral fiber, 1/16 inch thick, equivalent to Garlock Style 9800, Durlon 8300, or equal.
   3. Bolting materials: Carbon steel heavy hex bolts and nuts, ASTM A307, type B.
      1. Joints:
8. 2-inch and smaller: 95 percent tin and 5 percent antimony solder with non-acid flux type flux, ASTM B32, grade 95TA.
9. 2 ½-inch and larger: Standard weight, seamless steel; welding fittings and flanges ASTM A234 and ANSI/ASME B16.9 for fittings and ASTM A181 or ASTM A105 for flanges.
   * 1. Unions:
10. 2-inch and smaller Wrought solder type, copper to copper; furnish ground joint cast bronze low lead unions, NIBCO 733, where copper connects to steel.
11. 2 ½-inch and larger: Refer to Section 23 0513, Basic HVAC Materials and Methods, for threaded pipe joints and welded connections.
    1. Valves: Chilled Water and Condenser Water.
12. Ball Valves, 2-inch and Smaller: Shall be 600 psi CWP, have cast brass bodies, replaceable reinforced Teflon seats, conventional port, blowout proof stems, chrome plated brass ball, and threaded or solder ends with extended solder cups.

Threaded Solder

Stockham T-285-FB-R-70 (full port) Stockham S-285-FB-R-70 (full port)

Crane 9301 Crane 9302

Worcester 44-11-RT-SE Worcester 44-11-RT-TE

Jamesbury 351T ---

Apollo 70-100 Apollo 70-200

Equal

1. Gate Valves, 2-inch and Smaller:

Class 125, body and bonnet ASTM B62. Cast bronze composition. Threaded or soldered ends. Solid disc, copper-silicon alloy stem, brass packing gland. Threaded ends: Stockham B-100 (RS) or B103 (NRS), Crane 428 or 438, Hammond IB640 (RS) or IB645 (NRS), or equal. Soldered ends: Stockham B104 (NRS) or B108 (RS), Milwaukee 115 (NRS) or 149 (RS), NIBCO S-113 (NRS) or S-111 (RS), or equal.

1. Gate Valves, 2 ½-inch and Larger:

Class 125 iron body, bronze mounted, ASTM A126, class B cast iron, flanged ends with Teflon impregnated packing and 2-piece packing glass.

OSY RS NRS

Stockham G-623 G-612

Crane 465 1/2 461

Powell 1793 1787

Hammond IR1140 IR 1138

Equal

1. Butterfly Valves: 150 psi tight shut-off, ASTM A126.
2. Body: Lug type, ASTM A126iron.
3. Disc:
   * 1. For motorized valves: 304 Stainless Steel.
     2. For Manual Valves: Cadmium-plated ductile, iron for chilled water (bronze, or aluminum bronze for condenser water).
4. Stem:
   * 1. For motorized valves: 416 Stainless Steel.
     2. For manual Valves: Solid one-piece, 304 or 316 or 410 stainless steel.
5. Seat and O-rings: EPDM O-ring.
6. Upper and lower stem bearings: Bronze or reinforced Teflon.
7. Operators:
   1. Valves 6-inch and smaller: Bray Series 21 as basis of design or Center Line, Stockham, Crane, Belimo, Nibco or equal, with lever handle, or Electric Actuator and disc position indicator.
   2. Valves 8-inch and larger: Bray Series 21 as basis of design or Center Line, Stockham, Crane, Belimo, Nibco or equal, manual gear operator and disc position indicator, or Electric Actuator.
8. Manufacturers: Bray, Milwaukee, Center Line, Stockham, Crane, DeZURIK, Belimo, Nibco or equal.
9. Check Valves, 2-inch and Smaller:

Shall be of class 125, threaded or solder ends, body and caps shall be of ASTM B62 cast bronze composition, swing type disc.

Threaded Solder

Stockham B-319Y Stockham B-309Y

Hammond IB 904 Hammond IB 912

Crane 37 Crane 1707S

Powell 578 Powell 1825

Equal

1. Class 150 valves meeting above Specifications may be furnished where pressure requires: Stockham B-321, NIBCO T-433-B, Milwaukee 515, or equal, threaded.
2. Check Valves, 2 ½-inch and Larger:

Shall be iron body, bronze mounted with body and cap conforming to ASTM A126, class B, cast iron, flanged ends, swing type disc.

Hammond IR1124

Stockham G-931

Crane 373

Powell 559

Equal

1. Alternative Check Valves, 2 ½-inch and Larger:

Shall be class 125/250, iron body, bronze mounted, wafer check valves, with ends designed for flanged type connection, aluminum bronze disc, EPDM seats, 316 stainless steel torsion spring, and hinge pin.

Stockham WG-961

Center Line Series 800

Duo-Chek K12 HAP

Marlin M125 HZDSF

Equal

1. Non-Slam Check Valves (Pump Discharge):

Semi-steel body, bronze trim, top and bottom center guide, stainless steel spring and 125 pound flanged ends. Miller Manufacturing No. 162 or equivalent by Williams-Hager, Val-Matic Valve & Manufacturing Corp., or equal.

1. Air Vents: Spirotherm model Spirovent as basis of design or Amtrol, Watts, Dole, Bell and Gossett, or equal, manual type, of size for proper venting. Install at high points of systems.
   1. Valves: Heating Hot Water, and Low-pressure Steam System.
2. Gate Valves, 2-inch and Smaller: Shall be of class 150 with body and union bonnet of ASTM B62 cast bronze composition, threaded or solder ends, solid disc, copper-silicon stem, brass packing gland, Teflon-impregnated packing, and malleable handwheel.

Threaded Solder

Stockham B-120 (RS)

Hammond IB629 Hammond IB648

Crane 431UB

Powell 2714

Equal

1. Ball Valves, 2-inch and Smaller: Shall be 600 psi CWP, have cast brass bodies, replaceable reinforced Teflon seats, conventional port, blowout proof stems, chrome plated brass ball, and threaded or solder ends with extended solder cups.

Threaded Solder

Stockham T-285-FB-R-70 (full port) Stockham S-285-FB-R-70 (full port)

Crane 9301 Crane 9302

Worcester 44-11-RT-SE Worcester 44-11-RT-TE

Jamesbury 351T ---

Apollo 70-100 Apollo 70-200

Equal

1. Gate Valves, 2 ½-inch and Larger: Shall be class 125 iron body, bronze mounted, with body and bonnet conforming to ASTM A126, class B, cast iron, flanged ends, with Teflon-impregnated packing and two-piece packing gland assembly.

OS & Y NRS

Stockham G-623 G-612

Hammond IR1140 IR1138

Crane 465 1/2 461

Powell 1793 1787

Equal

1. Check Valves, 2-inch and Smaller: Shall be class 150 with body and cap of ASTM B62 bronze composition and threaded ends. Class 150 valves shall have lift-type non-metallic disc and union caps, and are to be furnished in lines with globe valves.
2. For backflow prevention in lines with gate valves, Y-pattern valves with swing-type disc may be furnished.

Stockham B-322B

Crane 27TF

Equal

1. For class 150 service, threaded ends:

Stockham B-321 Crane 137

NIBCO T-433-B

Equal

1. For class 200 Service, threaded ends:

Hammond IB944 Crane 36

Stockham B-345 Powell 560

Equal

1. Check Valves, 2 ½-inch and Larger: Shall be iron body, bronze mounted, with body and cap conforming to ASTM A126, class B, cast iron, flanged ends, and swing-type disc.

Crane 373 Hammond IR1124

Powell 559 Stockham G-931

Equal

1. Alternative for above listed check valves shall be class 125/250 iron body, bronze mounted, wafer check valve, with ends designed for flanged type connection, aluminum bronze disc, EPDM seats, 316 stainless steel torsion spring, and hinge pin.

Center Line Series 800 Hammond IR9253

Marlin M125 HZDSF Duo-Chek G12 HAP

Stockham WG-961 Equal

1. Automatic valves controlling steam to a coil in a hot water tank shall be single seated type. When these valves are installed on a gravity return system, they shall be two position type (i.e. completely open or completely closed).
2. Valves on steam mains in boiler rooms shall be angle globe valves and be set to hold no condensate.
   1. Electric Motor Operated Valves: Belimo, Bray or equal.
   2. Valves, General:
3. Handles or hand wheels on valves shall be removable and, unless specified to be of loose key type, shall be securely fastened to their stems. Valve handwheels, except those on radiator valves, shall be of steel, brass, or cast iron.
4. Boiler shut-off valves and valves on steam mains installed more than 6 feet above floor, shall be furnished with chain wheels and chains to within 6 feet of floor. Chains shall be free hanging and in a position to permit operation of valve from floor. When pulleys or extensions are required to locate these chains in such a position, furnish, and install said pulleys or extensions as required to provide a satisfactory operating installation. Extensions over one foot long shall be furnished with a supported outboard bearing.
5. Furnish and install chains or wire rope with required accessories to open safety valves from boiler room floor.
6. Radiator or convector valves shall be corner or angle type with composition handles, composition renewable discs, packing gland, union nut on tailpiece, unless otherwise specified. If exposed, they shall have a finished or plated exterior.
7. Temperature Control Valves: Refer to Section 23 0513.
8. Flow Control Valves: Refer to Section 23 0513.
   1. Flow Measuring Devices: Refer to Section 23 0513.
   2. Strainers: Refer to Section 23 0513.
   3. Condensate Drain Piping, from Air Handling Units: Refer to Section 22 0513.
   4. Indirect Drains, Relief Valve Discharge Piping and Air Vent Discharge Piping:
      1. Pipe: Type L tempered copper water tube.
      2. Fittings: Wrought copper. Refer to Section 23 0513. Furnish copper to threaded international pipe size adapters at threaded connections.
      3. Joints:

Soldered: 95/5 solder.

* 1. Insulation: Refer to Section 23 0700.
  2. Pipe Anchors, Pipe Guides, Expansion and Contraction Devices:

1. Piping subject to expansion or contraction shall be fastened in a manner permitting strains to be evenly distributed and alleviated by swing joints or expansion loops or joints. Seismic restraints shall be installed so as not to interfere with expansion and contraction of piping.
2. Provide anchors in heating or cooling piping system, to restrain and control direction of movement for expansion or contraction in piping system.
3. Provide guides at specific locations in heating or cooling piping system in conjunction with slip or bellows type expansion joint.
4. When coils or unit housings are shock or vibration isolated, provide piping flexible metal connector not less than 10 inches long whether they are indicated on the Drawings or not.
   1. Flexible Metal Connectors:
5. Provide vibration elimination flexible metal connectors on chilled and hot water supply and return piping where rigidly supported pipes connects to unit housing coil attachments and units are supported by vibration isolators.
6. Schedule Numbers:
7. FMC-1: Corrugated bronze metal hose with outer bronze braid in tubular sheath of woven metal wires. Connector with female copper tube ends for copper piping. Metraflex model BBS, Unisource Style UPCB-BRSW, Microflex, or equal.
8. FMC-2: Corrugated stainless steel metal hose with outer stainless steel braid in tubular sheath of woven metal wires. Connector with male pipe threads (NPT) for threaded piping. Metraflex model SST, Unisource Style UPCS-MMT, Microflex, or equal.
9. FMC-3: Corrugated Bronze Metal Hose with outer bronze braid in tubular sheath of woven metal wires. Connector with female copper tubes ends for refrigeration piping. Metraflex model RAF, Unisource VIB, Anaconda Vibration Eliminators, or equal.
   1. Refer to Sections 23 0513for following:
10. Pipe Hangers and Supports.
11. Pipe Sleeves and Plates.
12. Pipe Flashings.
13. Relief Valves.
14. Thermometers.
15. Pressure Gages.
16. Pressure and Temperature Test Plugs.
17. Access Panels.
18. Dielectric Fittings.
19. Expansion Tanks.
20. Condensate Traps.

**2.02 EQUIPMENT**

1. Furnish centrifugal pumps capable of delivering rated capacity against total dynamic head as indicated on schedule and as specified for following:
2. Condenser Water Pump:
3. Single stage base mounted, vertical split case, cast iron, bronze fitted construction. Pump impeller, casing bearings, capable of being serviced without disturbing piping connections.
4. Impeller, enclosed type, hydraulically and dynamically balanced and keyed to shaft and secured with a suitable locknut.
5. Pump shall employ a mechanical seal, with a carbon seal ring and ceramic (or tungsten carbide) seat. A shaft sleeve furnished under complete wetted area of mechanical seal.
6. Bearing frame assembly of pumps fitted with oil lubricated bronze journal bearings and a hardened alloy steel shaft.
7. Flexible coupling to absorb torsion vibration between pumps and motor.
8. Motor: Resilient mounted, furnished with oil lubricated journal bearings.
9. Pump: Factory tested, thoroughly cleaned, and painted with one coat of machinery enamel prior to shipment. A set of installation instructions to be furnished with pump at time of shipment.
10. Acceptable manufacturers: Taco, Armstrong, Paco, Bell and Gossett, Grundfos, Weinman, or equal.
11. Chilled Water Pumps:
12. Horizontal, split case, fitted same as above, or end suction similar to that indicated below.
13. Frame mounted with flexible coupling on shaft.
14. Manufacturers: Taco, Armstrong, Paco Bell and Gossett, Weinman, or equal.
15. Hot Water Pumps: End suction, centrifugal, vertical split case, cast iron base mounted. Taco, Armstrong, Paco type L, Bell and Gossett, Grundfos, Weinman, or equal.
16. Boiler Feed Pump: Two-stage, bronze fitted mechanical seals, double suction, regenerative turbine type with cast iron housing. Construction shall permit disassembly of pump without disturbing suction and discharge pipe connections. Pump impeller shall be bronze, mounted on stainless steel shaft supported by ball bearing on each side of pump casing. Pump shall be directly connected with a flexible coupling to an open drip-proof motor and mounted on a common steel base. Pump shall be operated from a boiler water level controller mounted on boiler. Pump shall be Roth Pump Co., Skidmore, Aurora, or equal. Pumps shall be electrically interlocked to 24-hour day/night operating boiler controls.

**PART 3 – EXECUTION**

**3.01 PIPING INSTALLATION**

1. Install piping systems for chilled water, condenser water, and hot water and steam heating systems, condensate drains, and miscellaneous piping required for equipment, as indicated on Drawings and as specified in Section 23 0513.
2. All piping and fittings size 2-1/2” and larger shall be welded – No Grooved type fitting is allowed except at chiller barrel and condenser barrel connections.

**3.02 WATER PUMPS**

1. Install water pumps as indicated on Drawings and as specified unless otherwise noted. Provide vibration isolation and flexible pipe connections as specified in Sections 23 0548 and 23 0513.
2. Floor mounted pumps shall be provided with a 4-inch high concrete base. For base, refer to Section 03 3000: Cast-In-Place Concrete.
3. Provide leveling and alignment for base mounted pumps before and after installation.
4. Provide suction diffuser for pumps where space constraints exist.
5. Install pumps to allow complete removal without having to dismantle connecting pipes.
6. Piping shall be supported from building structure to prevent any strain on pump casing. In-line pumps shall be separately supported from piping by furnishing pump manufacturer's specialized spring support kit, if available; pump shall not be rigidly supported.
7. Flanged connections shall be provided on pumps with a discharge connection larger than 2 inches. Smaller sizes may be furnished with threaded connections. Except for special guided inlet fittings, inlets to suction side of pumps shall be a minimum of 10 diameters of straight pipe free from strainers, valves or fittings. On discharge side, minimum length of uninterrupted length of straight pipe shall be 5 diameters.
8. Pumps, one horsepower or larger, shall be installed with required pump connections for noise and vibration isolation and not to compensate for misalignment.

**3.03 AIR AND DIRT ELIMINATION**

1. Heating and chilled water piping and steam or hot water heating and/or cooling equipment shall be installed in a manner so that air will be eliminated from lines or equipment during operation. Pitch pipe lines as specified in Section 23 0513.
2. Manual air valve shall be installed at each high point of chilled or hot water circulating lines, on each chilled water or hot water heating unit unless unit can vent through outlet connection. Refer to valves as specified under Section 23 0513.
3. Air vent valves shall be installed with drains to nearest floor sink or outside building.
4. Air/Dirt separators shall be installed on all hot water heating system, chilled water system, and closed loop fluid cooler system. Units shall be furnished with internal copper coalescing medium to facilitate maximum air and dirt separation and suppress turbulence. Units shall be furnished with galvanized steel strainer and stainless steel collector tube. Provide integral high capacity float actuated air vent at top fitting of tank. Furnish cast iron float actuated air vent rated at 150 psig, threaded to the top of the fitting. Unit shall be furnished with the bottom of the vessel extended for dirt separation with the system connection nozzles equidistant from the top and bottom of the vessel and shall include a blowdown connection and valve. Refer to Air/Dirt separators as specified under Section 23 0513.
5. Acceptable manufacturers: Spirotherm, Bell and Gossett, Wessels, or equal.

**3.04 CHEMICAL POT FEEDER**

1. Provide a chemical pot feeder in each of chilled water and hot water systems as specified in Section 23 2500: HVAC Water Treatment.

**3.05 CONDENSER WATER TREATMENT**

1. Provide condenser water treatment as specified in Section 23 2500: HVAC Water Treatment.
   1. **CLEANUP**
2. Remove rubbish, debris and waste material and legally dispose of off the Project site.

**3.07 PROTECTION**

1. Protect the Work of this Section until Substantial Completion.

**END OF SECTION**