

SECTION 224400 – WATER SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and other plumbing systems are specified in other Sections of Division 22.
- B. Refer to Section 220010, Plumbing General, for a list of plumbing sections included in this specification.
- C. This Section covers plumbing water systems.

1.2 QUALITY ASSURANCE

- A. Conform to the following:
 - 2. North Carolina State Energy Conservation Code-2018.
 - 3. North Carolina State Plumbing Code-2018.
- B. Specialty piping joint certification: installers shall be certified by the manufacturer of the piping joint system, prior to any installation.
- C. Wetted components in the potable water system, where the water is anticipated for human consumption, shall comply with the Reduction of Lead in Drinking Water Act-2011.

PART 2 - PRODUCTS

2.1 PIPING, FITTINGS, AND JOINTS

- A. General:
 - 1. Piping and fitting sizes listed are nominal inside diameter.
 - 2. For copper pipe applications, use mechanically crimped copper joint systems, OR use solder joints and flux that comply with ASTM B828 2016, and ASTM B813 2016, respectively.
 - 3. For water intended for human consumption:
 - a. Use pipes and pipe fittings that comply with California Law AB1953, which requires that the wetted surface area have a weighted average lead content of not more than 0.25%.
 - b. Solder and flux used to connect plumbing pipe on site shall meet California AB1953 standard, which specifies that solder not contain more than 0.2% lead, and flux not more than a weighted average of 0.25% lead for wetted surfaces.
- B. Cold water, hot water, and hot water circulating, underground, 2.5" and larger:
 - 1. Piping: copper tubing, type K, hard temper, ASTM B88-2016.
 - 2. Fittings: wrought copper, ASME B16.22-2018.
 - 3. Joints: brazed with brazing filler metal, BcuP-3, silver-phosphorous, AWS A5.8/A5.8M-2011.
- C. Cold water, hot water, hot water circulating, trap primer, and relief valve discharge, above grade, 0.5" to 2.5", except chromium-plated piping at fixtures:
 - 1. Piping: copper tubing, type L, hard temper, ASTM B88-2016.
 - 2. Fittings: wrought copper and/or cast bronze socket fittings, 0.5" to 2.5", ASME B16.22-2018.
 - 3. Fittings: wrought copper press fittings, ASME B16.22-2018 with EPDM elastomeric O-ring seals, may be used at the Contractor's option for sizes 0.5" to 2.5".

- a. Manufacturer: NIBCO Press Fittings, or Viega ProPress.
- 4. Joints:
 - a. Soldered with 95/5 tin/silver or tin/antimony alloy type, with a compatible flux designed to be cold water flushable in potable water systems, ASTM B813-2016 and NSF 61-2019.
 - b. Pressed type, using the tools and pressure requirements of the fitting manufacturer.
 - c. Cold water, and hot water, above grade, 3" to 8":
 - d. Piping: copper tubing, type L, hard temper, ASTM B88-2016.
- 5. Fittings:
 - a. For roll-grooved joints, 3" to 8": full flow standard radius, manufacturer supplied copper-tube dimensioned, roll-grooved of wrought copper, ASME B16.22-2018.
 - 1) Manufacturer: Anvil, Grinnell Mechanical Products, or Victaulic.
 - b. For brazed piping joints, 3" to 8": wrought copper and/or cast bronze socket fittings, ASME B16.22-2018.
- 6. Joints:
 - a. Brazed with brazing filler metal, BcuP-3, silver-phosphorous, AWS A5.8/A5.8M-2011.

2.2 SPECIALTY PIPING JOINTS

- A. Unions:
 - 1. For copper piping 2" and smaller: cast bronze with copper soldered connections.
 - 2. For steel piping 2" and smaller: ground joint with brass-to-iron seat.
 - 3. For piping of dissimilar metals 2" and smaller: provide dielectric unions with solder or threaded connections, nylon insulators, and minimum 600 V no flashover.
 - 4. For press fit piping 2" and smaller: hexagonal threaded type with press fit ends.
- B. Flanges:
 - 1. For copper piping 2.5" and larger: class 150, cast bronze companion flange NSF 61-2019 lead free, with solder cup, and flat flange face. Provide a 0.125" thick EPDM NSF/ANSI 61 type rubber gasket.
 - 2. For piping of dissimilar metals 2.5" and larger: provide dielectric flanges with solder or threaded pipe connections. Provide a 0.125" thick EPDM NSF/ANSI 61 type rubber gasket.
 - 3. Flanges for equipment connections shall match the equipment's flange in style, material, and pressure rating. Provide a 0.125" thick EPDM NSF/ANSI 61 type rubber gasket.

2.3 VALVES

- A. General:
 - 1. Valves shall be of the same manufacturer, except where a specific product is not available.
 - 2. Stem packing: asbestos-free.
- B. Gate Valves:
 - 1. Gate valves 3" and larger: class 250, iron body with bronze trim, outside screw and yoke, bolted bonnet, solid wedge, renewable seats, flanged ends, 500 psig wog, MSS SP-70-2011.
 - a. Manufacturer: Apollo 621F series, Hammond IR330, Milwaukee F-2894, or NIBCO F667-O.
- C. Globe Valves:

1. Globe valves 2.5" and smaller: class 125, bronze body with threaded bonnet, integral seat, renewable bronze seat and disc, 200 psig wog.
 - a. Manufacturer (solder ends): Apollo 121S-LF, Hammond UP418, or Milwaukee UP1502.
 - b. Manufacturer (threaded ends): Apollo 121T-LF, Hammond UP440, or Milwaukee UP502.
2. Globe valves 3" and larger: class 250 iron body with bronze or stainless steel trim, outside screw and yoke, bolted bonnet, integral guide for proper alignment of seat to disc, renewable bronze disc and seat, flanged ends, 500 psig wog, MSS SP-85-2011.
 - a. Manufacturer: Apollo 721F, Hammond IR313, Milwaukee F-2983, or NIBCO F-768-B.

D. Ball Valves:

1. For copper piping, 2" and smaller: 2-piece bronze or bronze alloy body, full port, with blowout-proof stem, rated for 600 psig wog. Valves shall have a stainless steel ball, reinforced seat, stuffing box ring, memory stop, and lever handle. Valves in insulated piping shall have 1.25" extended stems.
 - a. Manufacturer (soldered ends): Apollo 77CLF-240, Hammond UP8313A, Milwaukee UPBA450S, or NIBCO S-585-66-LF.
 - b. Manufacturer (threaded ends): Apollo 77CLF-140, Hammond UP8303A, Milwaukee UPBA400S, or NIBCO T-585-66-LF.
2. For copper press fitting piping, 2" and smaller: 2-piece bronze or bronze alloy body, full port, with blowout-proof stem, rated for 200 psig wog. Valves shall have a stainless steel ball, reinforced TFE seat, stuffing box ring, grade E EPDM elastomeric O-ring seals, and press by press female ends. Valves in insulated piping shall have 1.25" extended stems.
 - a. Manufacturer: Apollo 77WLF-140 series, NIBCO PC585-66-LF, or Viega ProPress 2970.3ZL.

E. Butterfly Valves:

1. For flanged piping, 2" and larger: drilled and tapped lug type with ductile iron body, 316 stainless steel disc, EPDM seat designed for service at 200 psig and 200°F, stainless steel shaft, permanently lubricated bushings on each end of the shaft, and conforming to MSS SP-67-2017. Butterfly valves shall be factory hydrostatically tested at 150% of operating pressure, factory-tested bubble-tight at 150 psig disc differential, and shall be designed for dead-end service without a back-up flange. Operators shall be the lever and quadrant type for valves 2" and 3", and manual hand-wheel gear type for valves 4" and larger.
 - a. Manufacturer: Apollo 141 series, Hammond 6411 series, Milwaukee ML233E and ML333E, or NIBCO LD-2000.

F. Check Valves:

1. Check valves 2.5" and smaller: class 125, bronze body, Y-pattern horizontal swing with renewable bronze disc and seat, screw cap, 200 psig non-shock cwp.
 - a. Manufacturer (solder ends): Apollo 161S-LF, Milwaukee UP1509, or NIBCO S-413-Y-LF.
 - b. Manufacturer (threaded ends): Apollo 161T-LF, Milwaukee UP509, or NIBCO T-413-Y-LF.
2. Check valves 3" and larger: class 125, iron body, dual-disc wafer type with spring hinge, bronze disc, EPDM seat, 200 psig non-shock cwp.
 - a. Manufacturer: Apollo 910WB, Hammond IR9253, or NIBCO W-920-W-LF.

2.4 STRAINERS

- A. Strainers 2.5" and smaller: class 125, bronze body, Y-pattern, with a 20 mesh type 304 stainless steel screen, threaded cap, 200 psig non-shock cwp.
 - 1. Manufacturer (solder ends): Apollo 59LF-300, or Wilkins YBXL.
 - 2. Manufacturer (threaded ends): Apollo 59LF-000, or Wilkins YBXL.
- B. Strainers 3" and larger: class 125, iron body, Y-pattern, with FDA coating inside and outside, type 304 stainless steel screen, bolted cap, with blow-off plug and valve, flange ends, 200 psig non-shock cwp.
 - 1. Manufacturer: Apollo 125-YF, Hammond 3030, or NIBCO F-721-A.

2.5 HOSE BIBS

- A. For mechanical or equipment spaces: chromium-plated brass with 0.75" inlet, tee handle, built-in atmospheric vacuum breaker, and 0.75" hose thread outlet.
 - 1. Manufacturer: Chicago 952 XKCP, T&S B-0722-RGH, or Zurn Z875L7.
- B. For finished areas: polished chromium-plated brass with 0.75" inlet, tee handle, built-in atmospheric vacuum breaker, and 0.75" hose thread outlet.
 - 1. Manufacturer: Chicago 952XK, T&S B-0722, or Zurn Z875L7.

2.6 HYDRANTS

- A. Wall Hydrants:
 - 1. Non-freeze type with bronze body and casing, 0.75" threaded inlet, 0.75" hose thread outlet, integral vacuum breaker, key handle, adjustable wall clamp, recessed box with hinged locking cover with the word WATER cast in, and polished bronze finish.
 - a. Manufacturer: Josam 71000, Smith 5509 QT, Wade 8600-175, or Zurn Z-1300.
- B. Roof Hydrants:
 - 1. Fully self-contained nonfreeze post type hydrant consisting of a brass wheel handle hose bib, 0.75" hose thread backflow preventer, riser post, integral stainless steel drain back canister with vent pipe for freeze protection, self-adjusting solid brass operating rod with replaceable O-ring seal, and 0.75" threaded brass inlet.
 - a. Manufacturer: Hoepfner 2131R, or Woodford SRH-MS.

2.7 PRESSURE REDUCING VALVES

- A. Direct operating type with low capacity, bronze body, stainless steel spring, sealed spring chamber, stainless steel seat ring, composition disc, built-in bypass, and threaded ends. Provide units with isolation valves, pressure gauges, and strainers.
 - 1. Manufacturer: Apollo PRCLF, or Wilkins 70XL.
- B. Direct operating type with high capacity, bronze body, stainless steel spring, sealed spring chamber, stainless steel seat ring, composition disc, built-in bypass, and threaded ends. Provide unit with isolation valves, pressure gauges, and separate wye pattern strainer.
 - 1. Manufacturer: Apollo PRLF, or Wilkins 500XL.

2.8 BACKFLOW PREVENTERS

- A. Reduced pressure type for cold water 0.75" to 2": with bronze body, stainless steel working parts, check modules, test cocks, relief module, and threaded ends. Provide the assembly with isolation valves, air gap drain device, and separate wye pattern strainer.
 - 1. Manufacturer: Apollo RP4ALF, or Wilkins 975XL.
- B. Reduced pressure type for hot water 0.75" to 2": with bronze body, stainless steel working parts, check modules, test cocks, relief module, threaded ends, and all parts designed for 140°F water service. Provide the assembly with isolation valves, air gap drain device, and separate wye pattern strainer.
 - 1. Manufacturer: Apollo RP4ALF, or Wilkins 975XL.
- C. Reduced pressure type for cold water 2.5" to 8": with type 304 stainless steel body inside and out, stainless steel working parts, check modules, test cocks, relief module, and grooved or flanged ends. Provide the assembly with FDA epoxy coated OS&Y isolation valves, air gap drain device, and separate wye pattern strainer.
 - 1. Manufacturer: Apollo RP4ALF, or Wilkins 375AST.
- D. Double check valve assembly type for cold water 0.75" to 2": with bronze body, stainless steel springs, guides, fasteners, corrosion resistant check modules, renewable seats, test cocks, and threaded ends. Provide the assembly with isolation valves and separate wye pattern strainer.
 - 1. Manufacturer: Apollo DC4ALF, or Wilkins 95XL.

2.9 VACUUM BREAKERS

- A. Pressure type, spill resistant for cold and hot water 0.5" to 1": with bronze body, check valve, replaceable valve seat, spring-loaded float disc, stainless steel springs, vent disc with isolation to the water stream, inlet/outlet isolation valves, and operating temperature to 180°F.
 - 1. Manufacturer: Apollo SVB4WLF, or Wilkins 460XL.

2.10 TRAP PRIMERS

- A. Brass construction, capacity to prime traps as indicated on the Drawings, line pressure operation.
 - 1. Manufacturer:
 - a. Trap primer for flush valve lines: Precision Plumbing Produces, Prime-Rite.
 - b. Trap primer for faucet lines: Precision Plumbing Products, Oregon 1 PO-500.
 - c. Distribution unit: Precision Plumbing Products, DU-4.
- B. Automatic trap primer panels: factory-assembled packaged trap primer manifold with atmospheric vacuum breaker, preset 24 hour timer set for 10 seconds (minimum) operation every 24 hours, manual override switch, 120 V solenoid valve, 0.75" inlet connection, 0.5" outlet compression fittings, water hammer arrester and enclosed in a 16 gauge steel cabinet with prime coated access door.
 - 1. Manufacturer: Precision Plumbing Products Prime-Time Manifold.
- C. Automatic mini trap primers: electronic trap primer with distribution unit, 1" air gap, preset 24 hour timer set for 10 second minimum operation every 24 hours, manual override switch, fuse, 120 V solenoid valve, 0.5" inlet connection, and 0.375" outlet compression fittings.
 - 1. Manufacturer: Precision Plumbing Products Mini-Prime, or Zurn Z-1020-ETP.

2.11 WATER HAMMER ARRESTERS

- A. Enclosed piston type with copper tubing enclosure, FDA approved double O-ring seals, threaded connections, ASSE 1010-2004 certified.
 - 1. Manufacturer: Precision Plumbing Products SC series, Sioux Chief 650 series, Smith 5200 series, Watts LF15M2 series, or Wilkins 1250XL.

2.12 PRESSURE GAUGES

- A. Bourdon tube type with stainless steel tube and socket, stainless steel movements with 0.5% accuracy over the full scale, and 150°F minimum operating temperature.
- B. The wetted parts shall be housed in a flangeless metal case with a clear safety glass lens, stainless steel front ring, and stainless steel 0.25" NPT lower connection. Provide each gauge with a stainless steel pressure snubber and needle valve 250 psig for piping connections.
- C. The dial face shall be white painted aluminum 4.5" in diameter with black graduations and letterings. The units of measure shall be in psig. The pointer shall be black painted aluminum and adjustable.
- D. Gauges shall be selected where the average pressure is at the scale's midpoint, and incorporating the following as applicable:

<u>Location</u>	<u>Scale Range</u>
Inlet of pressure reducing valves	0 to 200 psig.
Outlet of pressure reducing valves	0 to 100 psig.
Inlet of water pressure booster systems	0 to 200 psig.
Outlet of water pressure booster systems	0 to 300 psig.

- E. Fill liquid-filled gauges with food grade glycerin.
- F. Manufacturer:
 - 1. Filled case: Trerice 700 series, Weiss PFP series, Weksler HY44-8, or Winters PFP-SG4.

2.13 THERMOMETERS

- A. Blue- or green-reading organic-filled every-angle, industrial type with aluminum case, glass lens, 9" scale length, and accuracy rating of \pm one scale division. Thermometers installed in insulated piping shall have 6" stems with brass thermowell, filled with heat transfer medium, and extension.
- B. Scale range: 30°F to 240°F.
- C. Manufacturer: Trerice BX9-SPB, Weiss A9VU, Weksler EG5L-9, or Winters 9IT.

2.14 WATER HEATERS

- A. Commercial electric water heater, 120 gallons and smaller, UL listed packaged unit with vertical storage tank, heating elements, ASME pressure and temperature relief valve, controls with enclosure, and meeting the mandatory provisions of ASHRAE/IES 90.1-2019 and ANSI Z21.10.3-2017/CSA 4.3-2017.
 - 1. Controls: upper and lower immersion thermostats, temperature adjustment control, high temperature shut-off, low water shut-off, and low watt density immersion heating elements with time sequencer configuration.

2. Tanks: cement- or glass-lined carbon steel, 125 150 psig working pressure, polypropylene or cross-link polymer dip tube, and drain valve. For tanks with porous linings provide a magnesium anode rod.
3. Enclosures: minimum K value of 2.17 Btu·in/(h·ft²·°F) at 80°F for tank insulation, and steel jacket with baked enamel finish.
4. Warranty: the complete water heater assembly shall be provided with a nonprorated warranty, in writing, by the manufacturer for a period of 1 year from heater start-up. The warranty shall include defects in the design and construction of the assembly, including parts and components. Additionally, there shall be a nonprorated 3 year warranty against tank failure due to rust, and an operational warranty for odor and discolored water due to tank rust or tank lining. The warranty shall cover all costs including parts, heaters, shipping, and labor, with no cost being incurred by the Owner. If repairs are unable to be performed, the water heater shall be replaced with an equal unit.
5. Manufacturer: Bock, Bradford White, Hubbell, Lochinvar, Rheem/Ruud, A.O. Smith, or State.

B. Commercial electric water heater, 125 gallons and larger, UL listed packaged unit with vertical storage tank, heating elements, ASME pressure and temperature relief valve, controls with enclosure, meeting the mandatory provisions of ASHRAE/IES 90.1-2019 and ANSI Z21.10.3-2017/CSA 4.3-2017.

1. Controls:
 - a. Upper and lower immersion thermostats, temperature adjustment control, high temperature shut-off, high and low pressure shut-off, low water shut-off, magnetic contactors, control circuit transformer, control circuit switch, fuse and pilot light, fuses for each power circuit, 7 day time switch, and safety door interlock.
 - b. Communications port to communicate with the building control system to monitor that the heater is on or off.
2. Heating elements: immersion type, heavy duty, 80 W/in² maximum density, flange-mounted with incoloy sheath, maximum of 18 kW per element.
3. Tanks: cement-, glass- or polymer-lined carbon steel, designed, constructed, certified, and stamped in accordance with ASME BPVC-VIII-1-2019 for a 150 psig working pressure, with hand-hole cleanout, drain valve, and baffled inlet. For tanks with porous linings provide a titanium anode rod.
4. Enclosures: minimum K value of 2.17 Btu·in/(h·ft²·°F) at 80°F for tank insulation, and steel jacket with baked enamel finish.
5. Warranty: the complete water heater assembly shall be provided with a nonprorated warranty, in writing, by the manufacturer for a period of 1 year from heater start-up. The warranty shall include defects in the design and construction of the assembly, including parts and components. Additionally, there shall be a nonprorated 3 year warranty against tank failure due to rust, and an operational warranty for odor and discolored water due to tank rust or tank lining. The warranty shall cover all costs including parts, heaters, shipping, and labor, with no cost being incurred by the Owner. If repairs are unable to be performed, the water heater shall be replaced with an equal unit.
6. Manufacturer: Hubbell, Lochinvar, PVI, or A.O. Smith.

2.15 HOT WATER CIRCULATING PUMPS

- A. Single-stage, horizontal inline centrifugal type, with bronze body, bronze impeller, carbon steel shaft, oil lubricated bronze sleeve bearings, flexible coupling, and motor.
1. Manufacturer: Armstrong H series, Bell & Gossett PR series, or Grundfos Circulator series.

2.16 HOT WATER CIRCULATING PUMP TIMERS

- A. Time switch with a 24-hour dial, day-omitting device, self-starting synchronous motor, and removable on-off trippers.

- B. Provide with a NEMA 1 enclosure finished with a baked epoxy paint coating, 0.5" and 0.75" knockouts on bottom, sides and back, and provisions for locking or sealing.
- C. Provide a spring-driven reserve to operate the time switch contacts for at least 16 hours after power failure. On restoration of power the time switch shall transfer to the motor drive and automatically rewind the reserve.
- D. Manufacturer: Intermatic T170CR series, or Tork 7000L series.

2.17 HOT WATER CIRCULATING FLOW CONTROL FITTINGS

- A. Automatic Flow Control Fittings:
 - 1. Flow regulator type fittings with a brass body, removable factory preset flow balancing cartridge and orifice regulator, and stainless steel and brass flow elements. Flow rates shall be controlled to within $\pm 5\%$ of factory preset flow rate over varying pressure ranges. Trim fittings with a union connection, ball valve, and threaded or soldered ends.
 - 2. Manufacturer: Autoflow AC series, Griswold Flowcon series, or Nexus Valves Ultra Matic UM.

2.18 HOT WATER CIRCULATING FLOW METERS

- A. Inline threaded body flow meters with an accuracy of $\pm 5\%$, and operating parameters of 175 psig at 200°F. Meters shall be designed for potable water usage, able to measure flows from 0.5 gpm to 5.0 gpm and mountable in both horizontal and vertical positions.
- B. Manufacturer: Ernst EFI Inflo, Kobold VKP, or Racine Federated EZ-View.

2.19 THERMAL EXPANSION TANKS

- A. Inline expansion tanks shall be the bladder type with welded steel construction, primed and painted exterior, and designed for potable water. Diaphragms shall be FDA approved elastomeric, butyl rubber, designed for a maximum operating temperature of 180°F, and a minimum of 100 psig working pressure. Tanks shall be precharged to a minimum of 40 psig.
 - 1. Manufacturer: Amtrol Therm-X-Trol, Bell & Gossett PTA, or Watts PLT.
- B. Free-standing, vertical type with FDA approved fixed butyl bladder type designed for potable water. Tanks shall be precharged to a minimum of 40 psig. Tanks shall be welded carbon steel, have stainless steel connections, be constructed in accordance with ASME BPVC-VIII-1-2019, have a primed and painted exterior, and be designed for a maximum operating temperature of 240°F and a minimum of 125 psig working pressure.
 - 1. Manufacturer: Amtrol Therm-X-Trol, Bell & Gossett PTA, or Watts DETA.

2.20 RELIEF VALVES

- A. Temperature and pressure relief valves: 0.75" to 2", ASME rated, automatic self-closing pressure and temperature relief type with bronze or copper alloy body, stainless steel springs, non-mechanical seat-to-disc alignment, test lever, thermostat, and stainless steel or FDA approved coated temperature probe. Valves shall be in accordance with ANSI Z21.22-2015/CSA 4.4-2015, and shall be set for 80 psig pressure relief and 210°F temperature relief.
 - 1. Manufacturer: Apollo LF18C-500, Cash Acme FVX-LF series, or Watts LF series.

2.21 MIXING VALVES

- A. Single fixture mixing valves: thermostatic type mixing valve with bronze or brass body, chromium-plated finish, lockable temperature setting, 0.5" inlets with integral check valves, 0.5 gpm minimum flow, and conforming to ASSE 1070-2015/ASME A112.1070-2015/CSA B 125.70-15.
 - 1. Manufacturer: Leonard 270 LF, Powers LFLM495, or Symmons 7-225.
- B. Building master mixing valves: high/low mixing valve assembly with bronze body, self-contained, thermostatically controlled mixing valves with adjustable setpoints, check-stop inlets, union inlet and outlet connections, dial thermometer on discharge and copper piping. High/low assemblies shall have a minimum flow rate of 0.5 gpm and include 2 mixing valves in parallel and an intermediate pressure reducing valve with pressure gauges. Assembly shall be factory assembled and tested in accordance with ASSE 1017-2009. Provide a satin spray finish to the completed assembly.
 - 1. Manufacturer: Leonard TMLF Hi/Low series, Powers LFMM430 Hi/Low series, or Symmons 7 Hi/Low series.

2.22 WATER PRESSURE BOOSTER SYSTEMS

- A. General:
 - 1. The pump assembly shall be manufactured specifically for this Project.
 - 2. Provide a pre-piped and pre-wired skid-mounted factory assembly requiring only three building system connections: water supply, water discharge, and electrical supply. The assembly shall be a variable speed system with vertical diffuser pumps.
- B. Controls:
 - 1. Enclosure: controls shall be housed in a NEMA 1 ventilated stainless steel enclosure mounted on the assembly's stainless steel base frame. Bare steel shall be primed and finished with 2 coats of enamel paint.
 - 2. On/off controls: the system shall be turned on and off by a pressure transmitter mounted on the discharge header, with a NEMA 4X housing, and having a minimum accuracy of $\pm 0.5\%$ full scale.
 - 3. Power Controls:
 - a. A single-point power connection.
 - b. A main through-the-door power disconnect switch, interlocked with door.
 - c. H-O-A multiposition selector switch disconnects for each motor, mounted on door.
 - d. Circuit breakers shall have a minimum 65000 AIC rating, and fuses shall be Class R with a minimum 100000 AIC rating.
 - e. Low voltage control transformer.
 - f. Magnetic motor starters with 3-leg motor starter protection.
 - g. Individual pump running lights.
 - h. Individual pump mechanical failure, with light and pump transfer.
 - i. Field adjustable pressure setpoints.
 - j. 3-phase lightning arrestor.
 - 4. Logic controls: the system shall be controlled by a programmable logic controller and shall include:
 - a. LCD display.
 - b. Operator interface with keypad.
 - c. Field adjustable setpoints.
 - d. Self-diagnostic testing.
 - e. Copper sensing lines, except where the pressure rating is above the tubing's rated pressure, lines shall be stainless steel hydraulic tubing.
 - f. Clock.
 - g. Communication ports with digital inputs and outputs.

- h. Expansion ports.
 - 5. Pump controls: pumps, whether in primary or lag mode, shall have minimum run timers, start delay timers, selector switches, manual alternator, and automatic duty cycle to alternate pumps from lead to lag operation every 24 hour time period.
 - 6. Pressure controls: provide a low suction pressure shutdown set at 10 psig with alarm (with silence button) and light, and a remote low suction pressure alarm with manual reset. Provide panel-mounted suction and pressure gauges. Additionally, provide high suction pressure shutdown with alarm, light and automatic reset, and high system pressure shut down with delay timer, light, and automatic reset.
 - 7. Interface controls: provide status dry contacts that will interface with the building control system to indicate pump system on, low suction pressure, low system pressure, high system pressure, and general alarm.
 - 8. The complete control panel shall comply with UL 508A-2018.
- C. Variable Frequency Drives:
 - 1. Provide a variable frequency drive (VFD) for each motor. Each drive shall be sized for the maximum possible amperage draw throughout the programmed sequence of pump operation, and be adjustable frequency.
 - 2. VFDs shall include:
 - a. Pulse width modulation.
 - b. Rotating load starting.
 - c. Keypad operator pad including LCD display.
 - d. Power on and alarm fault display.
 - e. During automatic operation, VFDs shall respond to the signal from the control panel's logic section.
 - f. Electric fault, automatic drive shutdown.
 - g. Automatic restart following power supply failure.
 - h. Operational data displays.
 - i. Complete service diagnostics.
 - 3. Proportion-integral-derivative controls shall be wired directly to the programmable controller, with the logic function incorporated in the controller.
- D. Motors:
 - 1. Motors shall be continuous duty open dripproof type, premium efficiency NEMA B with squirrel cage rotor and class F insulation system. Motors shall have a 1.15 service factor that shall not overload at any point on the pump curve. Motors shall be inverter rated for application with variable frequency drives.
 - 2. Motors shall have drive end roller bearings and operate at 104°F ambient. Motors shall meet CSA C390-2010 (R2019), and be equipped with manufacturer's nameplate.
 - 3. Motors shall have a steel shaft, bronze shaft sleeve, and face plate for mounting to horizontal end suction pumps.
 - 4. Motors shall have a steel shaft, and adapter face plate for mounting directly to the top of vertical diffuser pumps.
- E. Pumps:
 - 1. 2 vertical multistage diffuser, cast iron type with cast iron stool, stainless steel shaft, stainless steel fitted, replaceable mechanical seals without moving motor, thermal safety valve with purge assembly, flat face for mounting motor to top of pump, and stainless steel impeller.
 - 2. Provide for each pump: vibration isolation mounts, thermal protection, and a nonslam check valve on pump's discharge.
 - 3. Provide isolation valves on each side of each pump. Valves shall be by the same manufacturer and shall be either gate, full port ball, or lug type butterfly type, as the system size and pressure require.

4. Manufacturer: Aurora, Ebara, Patterson, or Peerless. Aurora, Ebara, Paco, Patterson, Peerless, or Taco.

F. Piping:

1. Piping on the assembly between pumps and valves, and including the header, shall be schedule 40 type 304 stainless steel with threaded, grooved, or flanged fittings.
2. Suction and discharge headers shall be supported from the base frame. Provide flanged ends on each header for connections to the building piping.
3. The pressure rating for piping, tubing, and joints shall exceed the Project's maximum pressure requirements.

G. System Assembly:

1. The complete packaged unit shall be assembled on a single primed and painted welded stainless steel base frame, with anchor lugs for bolting to the housekeeping pad. The complete assembly shall be UL listed Category QCZJ for packaged pump systems.
2. The assembly shall be packaged and wrapped to protect the system components, and shipped as an integral unit, unless otherwise required by the Contractor. The unit shall be ready for building plumbing and electrical connections.

H. System maintenance: each pump, motor, and nonslam check valve shall be serviceable while the balance of the pumping system is still in operation.

I. Factory test: the complete assembly shall be tested at the factory prior to shipment, and certified in writing that it was tested at, and meets the Project's maximum flow requirement with the project's scheduled inlet minimum pressure. The test report shall accompany the assembly as part of its official documentation.

J. Documentation: system drawings, description of control panel with wiring diagrams, documentation of the third party labeling (that the components are a system for the intended use), factory test report, Operation and Maintenance Manual with parts list, and system warranty.

K. Warranty: the assembly, in whole and in part, shall be warranted in writing by the manufacturer for a period of 18 months from shipment or 12 months from start-up, whichever comes first. The warranty shall include defects in the design and construction of the assembly, including parts and components. The warranty shall cover shipping cost of parts and components to and from the manufacturer to the site, and all Contractor labor, travel cost, and overtime labor rates if applicable, for repairs.

L. Manufacturer: Bell & Gossett, Canariis, Delta-P, Flo-Pak, QuantumFlo, or SyncroFlo.

2.23 FLEXIBLE CONNECTORS

- A. As specified in Section 220010, Plumbing General, for pressure and temperature of intended service.

2.24 WATER METERS

A. Turbine Meters:

1. Potable cold water meters 1.5" to 6": with bronze, copper alloy, or stainless steel main casing, magnetic drive, remote reading, permanently sealed register, hydronamically balanced floating rotor, stainless steel trim, $\pm 1.5\%$ register accuracy, leak detection, and meeting AWWA C701-2015 and NSF 61-2019.
2. The meter shall measure flow and provide totals in gallons.
3. Provide a factory installed electronic encoder on the meter, with probes to detect current flow, total volume to date, and leak detection. The encoder shall be wired to the BAS, and have software able to communicate the required information in digital format.

4. Manufacturer: Badger Recordall Turbo series, Hersey MVR series, or Neptune HP series.

2.25 ACCESSORIES

- A. Gaskets in water piping: 0.063" thick red rubber or asbestos-free composition sheet type, selected for the pressure, temperature and service of the specific joint.
- B. Bolts and nuts: ASTM A307-2014e1, Grade B.
- C. Stack sleeves: coated cast iron stack sleeve, with caulking recess, flashing flange, nonpuncturing flashing clamp ring, and pressure ring.
 1. Manufacturer: Josam 26450, Smith 1720, or Zurn Z-195.

2.26 TUBING AND PIPING SLEEVES

- A. Underground Tubing and Piping:
 1. For 0.5" to 1" noninsulated tubing and piping direct buried underground, wrap the complete length with a minimum of 4 mil virgin polyethylene sleeve conforming to ASTM D1248-2016. Sleeves for cold water shall be blue, and red for hot water.
 2. Manufacturer: IPS Water-Tite, Northtown, or Oatey.
- B. Tubing and Piping in Contact with Concrete:
 1. For 0.5" to 1" noninsulated tubing and piping installed in contact with concrete slabs or concrete blocks, wrap the effected length with a minimum of 25 mil virgin polyethylene conforming to ASTM D1248-2016. Sleeves for cold water shall be blue and red for hot water.
 2. Manufacturer: Great Bay Products, or IPS Water-Tite.

2.27 FILTERS

- A. Ice Makers and Water Dispenser Filters:
 1. A changeable cold water filter system with minimum of 2 in-line filters, pressure gauges, 0.75" inlet and outlet connections, and wall mounting bracket with manifold. The system shall meet NSF and FDA requirements for safe drinking water.
 2. Filter systems shall be able to remove sediment 0.5 micron in size and larger, and reduce chloramine, chlorine, and cysts. Filters shall have a built-in inhibitor to reduce lime scale build-up.
 3. Filter systems shall have a minimum capacity of 70,000 gal volume usage with a flow rate of 5.0 gpm and a working pressure of 100 psig.
 4. Manufacturer: Bunn EQHP-TWIN 70L, Everpure CB20-302E, or 3M ICE260-S.

PART 3 - EXECUTION

3.1 GENERAL PIPING INSTALLATION

- A. General:
 1. Install all piping, fittings, and joints in accordance with the applicable manufacturer's instructions whether underground or aboveground.
 2. Piping shall be cut to measurements established at the site and worked into place without springing or forcing.
 3. Use concentric reducing fittings between different size pipes.

4. Ream steel, brass and copper pipe after cutting, turn on end and knock loose dirt, scale, and filings from interior of pipe.
5. Slope water piping to drain back to the mains.
6. Provide plastic pipe manufacturer's recommended expansion and contraction loops.
7. Install piping that is to receive insulation in a manner that when the insulation is installed, the finished wall of the insulation is not crushed nor in contact with any adjacent surface or equipment.

B. Underground:

1. Install water piping outside the building in trenches separate from sewers.
2. Excavation and backfill: as specified in Section 22 00 10, Plumbing General.
3. Underground piping shall be connected to the exterior service line, or capped or plugged if the exterior service is not in place.
4. Block ductile iron water pipe with concrete poured in contact with undisturbed earth. Provide tie rods for outside joints.
5. Piping installed below a footing's bottom elevation shall be installed a minimum of 12" horizontally from the footing for each 12" of depth below the footing.

C. Aboveground:

1. Piping shall be installed to permit free expansion and contraction, as controlled by pipe anchors, without damage to joints, hangers, or the building. Arrange piping to minimize stresses caused by expansion and contraction.
2. Group exposed pipe together and arrange control valves at fixtures for ease of operation.
3. Install piping so as to preserve access to valves and equipment and to provide the maximum headroom possible.
4. Provide offsets to maintain ceiling height and to coordinate with other trades.
5. Install exposed piping such that when insulation is applied it will not come in contact with adjacent surfaces.

D. Piping Joints:

1. General:
 - a. Isolate joints between dissimilar metals and connections to tanks with dielectric fittings.
 - b. Provide flanges, grooved couplings, or unions at connections to equipment.
 - c. Install mechanically grooved couplings and press fittings in accordance with the manufacturer's instructions, and provide factory trained personnel for installation.
2. Solder joints: pipe ends shall be cut square, deburred, cleaned and assembled in accordance with ASTM B828-2016.
3. Threaded joints: screw-thread joints shall be made with cut tapered threads. Joints shall be made tight with Teflon tape. Not more than 2 threads shall show after the joint is made tight, except no threads shall show in exposed chromium-plated piping.
4. Flanged joints: except at connections to equipment, flanged joints shall be made with ring type gaskets, extending to inside of bolt holes.
5. Press fitting joints: shall be made using the manufacturer's specific equipment for the piping joint being made, and by manufacturer trained personnel. Each pipe end shall be abutted full length into the fitting and marked accordingly.

3.2 PIPING, FITTINGS AND JOINTS

A. General:

1. Do not mix plastic pipe and fitting manufacturers. Use only the manufacturer's products approved by way of product data submittals.

B. Copper Tubing:

1. Noninsulated piping installed in masonry construction shall be painted 2 coats of asphaltum paint.
2. Clean, prime, and paint exposed noninsulated piping with 2 coats of glossy silver paint.

3.3 SPECIALTY PIPING JOINTS

A. Unions:

1. Provide in each piping connection to each piece of equipment where equipment may be removed.
2. Unions are not required where flanges or roll-grooved mechanical joint couplings are provided.

B. Flange Joints:

1. Provide in piping connections to equipment where flanges are provided.

3.4 VALVES

A. General:

1. Provide an isolation valve in the cold water service line near the point of entrance into the building. On the building side and near the gate valve, install a drain leg with 0.75" hose bib.
2. Provide a valve in each water supply connection to hose bibs, wall hydrants and water using equipment.
3. Install valves in clear locations so that handles and hand wheels are easily accessible for completely opening and closing of the valves.

B. Globe or Ball Valves:

1. Provide globe or ball valves in each water supply connection to sinks, water coolers, and any fixture provided by others, except where globe type stop valves are furnished with fixtures.

C. Butterfly Valves:

1. Butterfly valves may be used in lieu of gate valves indicated herein in systems operating at a maximum operating pressure of 150 psig.

3.5 AUTOMATIC FLOW BALANCING VALVES

- A. Install strainer valve upstream of automatic flow balancing valve.

3.6 STRAINERS

- A. Install in the inlet to each pump, pressure reducing valve, flow control valve, thermostatic mixing valve, backflow preventer, and as indicated on the Drawings or specified herein.

3.7 HYDRANTS

A. General:

1. Provide Owner with a loose key for each hydrant and obtain a receipt listing quantity and type of hydrant keys.

B. Wall Hydrants:

1. Install 18" above finished grade, except where building conditions and/or grade prevents the installation. Modify installation height as required, up to 36" above finished grade, where 18" will not work.

C. Roof Hydrants:

1. Order length of hydrant so that the wheel handle is approximately 27" above the finished roof.
2. Ensure that roof hydrants will winterize and provide manufacturer's winterizing information to Owner.

3.8 BACKFLOW PREVENTERS

- A. Drain line from each unit shall be DWV copper run full size to floor drain.

3.9 VACUUM BREAKERS

A. Pressure Type:

1. Install where water flow is continuous.
2. Install a minimum of 12" above the overflow level of the device being served.

B. Atmospheric Type:

1. Install where water flow is intermittent.
2. Install a minimum of 6" above the overflow level of the device being served.

- C. Install where spillage of water will not cause damage to room surfaces or equipment.

3.10 TRAP PRIMERS

- A. Connect trap primer lines to the drain tailpieces where field conditions prohibit connection to the trap primer connections on the drain bodies.

- B. Install trap primers with a straight downward slope to allow drainage from the trap primer valve.

3.11 WATER HAMMER ARRESTERS

- A. Install water hammer arresters in accordance with PDI WH201-2017.

3.12 PRESSURE GAUGES

- A. Provide filled gauges at the water pressure booster system.

3.13 THERMOMETERS

- A. Thermometer stems shall be installed in pipe tees with the stem in the water way flow stream. Thermometers shall be located so as to be easily read from 4.5' above the floor.

3.14 WATER HEATERS

- A. Install heaters level and stable.

- B. Start-up: a factory trained representative shall start-up each water heater. The representative shall submit a start-up report to the Contractor for inclusion in the Operation and Maintenance Manual.

3.15 HOT WATER CIRCULATING PUMPS

- A. Support pumps independently from piping by mounting at 48" above floor on wall with an angle iron frame.
- B. Do not restrain motor from floating on frame.

3.16 HOT WATER CIRCULATING PUMP TIMERS

- A. Set to turn the circulating pump on at hours set by Owner.
- B. Coordinate the day-omission setting with the Owner.

3.17 THERMAL EXPANSION TANKS

- A. Support tanks with hangers independently from adjacent piping or on the floor where floor bases are provided.

3.18 MIXING VALVES

- A. Connect mixing valves to the piping systems per the manufacturer's published installation recommendations.
- B. Secure each mixing valve assembly to a backboard mounted on the wall.
- C. Install each sensing bulb in a minimum 1" tee so that the bulb is completely washed by the flow.

3.19 WATER PRESSURE BOOSTER SYSTEMS

- A. Start-Up:
 - 1. A factory trained representative shall start-up the water pressure booster system. The Contractor shall not start the system without the factory trained representative.
 - 2. The representative shall check the electrical wiring connection, and the building piping connections before turning on the pump system. A start-up report shall be filled out by the representative and given the Contractor for inclusion in the Operation and Maintenance Manual.
- B. Owner Training:
 - 1. The Owner shall be trained by a factory trained representative.
 - 2. The training shall include:
 - a. The replacement of the motor, mechanical seals, and pump impeller.
 - b. Replacement of control panel fuses, chips, and pilot lights.
 - c. System operation, trouble-shooting, alarms, and re-set features.
- C. Dual power feed: provide 2 separate incoming power feeders, one primary and one standby, to a separate electrical panel (independent of the booster system) with electrical sensing and automatic power change-over if de-energizing of the primary feeder occurs so that the pumping system will remain in operation. Provide a single-point power feed to the booster pump's control panel.
- D. Pipe over-temperature discharge pipe to floor drain.

3.20 WATER METERS

- A. Install meter, piping, valves, and accessories per the manufacturer's requirements, and as indicated on the Drawings.
- B. Provide isolation valves, union or flange connections, and a separate wye pattern strainer at the meter's inlet.

3.21 TUBING AND PIPING SLEEVES

- A. Install sleeve over tubing or piping before installation, allowing room for expansion and turns.
- B. Inspect the sleeve closely for cuts or tears. Tape any cut or tear with water proof tape, wrapped around the sleeve and tubing or piping.
- C. Terminate sleeve a minimum of 10" above the floor.

3.22 ROOF PENETRATIONS

- A. Where pipes pass through the roof, flash with a sheet of 4 psf lead flashing extending at least 8" from the clamping ring in all directions.
 - 1. Provide a waterproof caulked joint in the top hub of each stack sleeve after the riser has been installed through the sleeve.
- B. Flash and counter-flash pipes passing through the roof with 4 psf sheet lead, not less than 18" square.

3.23 PIPING AND JOINT PRESSURE TESTING

- A. General:
 - 1. Test piping and joints under floor slabs before slabs are poured.
 - 2. Tests shall be made while piping and joints are exposed to view.
 - 3. Screwed, flanged, and grooved joints that leak shall be taken apart and reassembled.
 - 4. Soldered, brazed, and clamped joints that leak shall be cut out and replaced.
 - 5. Submit a statement certifying that piping and joints are tight and have passed the specified test.
- B. Piping Systems:
 - 1. Test cold water, hot water, and hot water circulating systems piping and joints by capping all openings and applying a hydrostatic pressure of 125 psig for 1 hour without any drop in pressure. Disconnect the pump source prior to and during testing. Where a system is tested in sections, each section shall be subjected to the same test.

3.24 PIPING SYSTEM TEMPERATURE TESTING

- A. Hot Water Systems:
 - 1. Following the installation of the piping systems, energize the water heaters and circulation pumps and bring the piping systems up to operating temperatures.
 - 2. Flow the hot water systems then allow the systems to stand for one hour before beginning testing.
 - 3. Perform hot water temperature checks at each fixture, and verify that the correct water temperature, as indicated on the Drawings, is flowing from each hot water outlet.
 - 4. Where any fixture's hot water temperature is incorrect, make adjustments as required to the water heaters, mixing valves, balancing assemblies, and circulation pumps.

B. Hot Water Circulation Systems:

1. For automatic flow control balancing fittings (preset from the manufacturer) verify that the correct flow fitting is installed, and that the accumulated flow is returning to the water heater. If flow is lower than indicated on the Drawings, remove and clean the flow control fittings.

C. Documentation:

1. Provide a document for the Operation and Maintenance Manual that dates, locates, and records the flow settings at each balancing station, and the temperatures recorded at each fixture.
2. Provide a copy of the meg-ohmmeter report for the Operation and Maintenance Manual.

3.25 CLEANING AND DISINFECTION

A. Domestic Water Piping:

1. Clean and disinfect inside water piping prior to placing the system in operation.
2. Purge domestic cold water, and hot water and hot water circulating piping, including heaters, pumps, tanks, and fixtures.
3. Flush the piping systems with potable water from the municipal supply system until water runs clear.
4. Fill the system with a water/chlorine solution containing a minimum 200 ppm chlorine. Isolate the piping systems and allow to stand for 4 hours.
5. Flush the systems with clean, potable water from the municipal supply system until the chlorine in the system is the same level as the municipal supply system.
6. Submit water samples for biological examination by laboratories approved by the local health authority. Samples shall be taken in the presence of the Owner.
7. Repeat the procedures and resubmit water samples as required to pass the biological test. Minimum acceptance test results shall be 0.0 colonies of coliform bacteria.
8. Provide results of tests.
9. Materials and test methods shall comply with AWWA C651-2014.

- B. Strainers: after final flushing of the water system, remove strainer baskets for cleaning and disinfection. Reinstall baskets and ensure that caps are leak tight.

END OF SECTION 224400