

GENERAL

1. Description

- a. The requirements of this Section apply to all sections of Division 22.
- b. This project will have selected building systems commissioned. The complete list of equipment and systems to be commissioned are specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. The commissioning process, which the Contractor is responsible to execute, is defined in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. A Commissioning Agent (CxA) appointed by the Department of Veterans Affairs will manage the commissioning process.

2. Summary

- a. This Section includes requirements for commissioning plumbing systems, subsystems and equipment. This Section supplements the general requirements specified in Section 01 91 00 General Commissioning Requirements.
- b. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for more specifics regarding processes and procedures as well as roles and responsibilities for all Commissioning Team members.

3. Definitions

- a. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for definitions.

4. Commissioned Systems

- a. Commissioning of a system or systems specified in Division 22 is part of the construction process. Documentation and testing of these systems, as well as training of the VA's Operation and Maintenance personnel in accordance with the requirements of Section 01 91 00 and of Division 22, is required in cooperation with the VA and the Commissioning Agent.
- b. The Plumbing systems commissioning will include the systems listed in Section 01 91 00 General Commissioning Requirements.

5. Submittals

- a. The commissioning process requires review of selected Submittals. The Commissioning Agent will provide a list of submittals that will be reviewed by the Commissioning Agent. This list will be reviewed and approved by the VA prior to forwarding to the Contractor. Refer to Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, and SAMPLES for further details.
- b. The commissioning process requires Submittal review simultaneously with engineering review. Specific submittal requirements related to the commissioning process are specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

EXECUTION

6. Construction Inspections

- a. Commissioning of the Building Plumbing Systems will require inspection of individual elements of the Plumbing construction throughout the construction period. The Contractor shall coordinate with the Commissioning Agent in accordance with Section 01 91 00 and the Commissioning Plan to schedule inspections as required to support the commissioning process.

7. Pre Functional Checklist

- a. The Contractor shall complete Pre-Functional Checklists to verify systems, subsystems, and equipment installation is complete and systems are ready for Systems Functional Performance Testing. The Commissioning Agent will prepare Pre-Functional Checklists to be used to document equipment installation. The Contractor shall complete the checklists. Completed checklists shall be submitted to the VA and to the Commissioning Agent for review. The Commissioning Agent may spot check a sample of completed checklists. If the Commissioning Agent determines that the information

provided on the checklist is not accurate, the Commissioning Agent will return the marked-up checklist to the Contractor for correction and resubmission. If the Commissioning Agent determines that a significant number of completed checklists for similar equipment are not accurate, the Commissioning Agent will select a broader sample of checklists for review. If the Commissioning Agent determines that a significant number of the broader sample of checklists is also inaccurate, all the checklists for the type of equipment will be returned to the Contractor for correction and resubmission. Refer to SECTION 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for submittal requirements for Pre-Functional Checklists, Equipment Startup Reports, and other commissioning documents.

8. Contractors Tests

- a. Contractor tests as required by other sections of Division 22 shall be scheduled and documented in accordance with Section 01 00 00 GENERAL REQUIREMENTS. . All testing shall be incorporated into the project schedule. Contractor shall provide no less than 7 calendar days' notice of testing. The Commissioning Agent will witness selected Contractor tests at the sole discretion of the Commissioning Agent. Contractor tests shall be completed prior to scheduling Systems Functional Performance Testing.

9. Systems Functional Performance Testing

- a. The Commissioning Process includes Systems Functional Performance Testing that is intended to test systems functional performance under steady state conditions, to test system reaction to changes in operating conditions, and system performance under emergency conditions. The Commissioning Agent will prepare detailed Systems Functional Performance Test procedures for review and approval by the Resident Engineer. The Contractor shall review and comment on the tests prior to approval. The Contractor shall provide the required labor, materials, and test equipment identified in the test procedure to perform the tests. The Commissioning Agent will witness and document the testing. The Contractor shall sign the test reports to verify tests were performed. See Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS, for additional details.

10. Training of VA Personnel

- a. Training of the VA operation and maintenance personnel is required in cooperation with the Resident Engineer and Commissioning Agent. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. Contractor shall submit training agendas and trainer resumes in accordance with the requirements of Section 01 91 00. The instruction shall be scheduled in coordination with the Resident Engineer after submission and approval of formal training plans. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS and Division 22 Sections for additional Contractor training requirements.

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GENERAL

1. Description

- a. Domestic water systems, including piping, equipment and all necessary accessories as designated in this section.
- b. A complete listing of all acronyms and abbreviations are included in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

2. Related Work

- a. Section 01 00 00, GENERAL REQUIREMENTS.
- b. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- c. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- d. Section 07 84 00, FIRESTOPPING.
- e. Section 07 92 00, JOINT SEALANTS.
- f. Section 09 91 00, PAINTING.
- g. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Seismic Restraint.
- h. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- i. Section 22 07 11, PLUMBING INSULATION.
- j. Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

3. Applicable Publications

- a. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- b. American Society of Mechanical Engineers (ASME):
 - i. A13.1-2007 (R2013), Scheme for Identification of Piping Systems
 - ii. B16.3-2011, Malleable Iron Threaded Fittings: Classes 150 and 300
 - iii. B16.9-2012, Factory-Made Wrought Butt Welding Fittings
 - iv. B16.11-2011, Forged Fittings, Socket-Welding and Threaded
 - v. B16.12-2009 (R2014), Cast Iron Threaded Drainage Fittings
 - vi. B16.15-2013, Cast Copper Alloy Threaded Fittings: Classes 125 and 250
 - vii. B16.18-2012, Cast Copper Alloy Solder Joint Pressure Fittings
 - viii. B16.22-2013, Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings
 - ix. B16.24-2011, Cast Copper Alloy Pipe Flanges and Flanged Fittings: Classes 150, 300, 600, 900, 1500, and 2500
 - x. B16.51-2013, Copper and Copper Alloy Press-Connect Fittings ASME Boiler and Pressure Vessel Code
 - xi. BPVC Section IX-2015, Welding, Brazing, and Fusing Qualifications
- c. American Society of Sanitary Engineers (ASSE):
 - i. 1010-2004, Performance Requirements for Water Hammer Arresters
- d. American Society for Testing and Materials (ASTM):
 - i. A47/A47M-1999 (R2014), Standard Specification for Ferritic Malleable Iron Castings
 - ii. A53/A53M-2012, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
 - iii. A183-2014, Standard Specification for Carbon Steel Track Bolts and Nuts
 - iv. A269/A269M-2014e1, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service

- v. A312/A312M-2015, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
- vi. A403/A403M-2014, Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings
- vii. A536-1984 (R2014), Standard Specification for Ductile Iron Castings
- viii. A733-2013, Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
- ix. B32-2008 (R2014), Standard Specification for Solder Metal
- x. B43-2014, Standard Specification for Seamless Red Brass Pipe, Standard Sizes
- xi. B61-2008 (R2013), Standard Specification for Steam or Valve Bronze Castings
- xii. B62-2009, Standard Specification for Composition Bronze or Ounce Metal Castings
- xiii. B75/B75M-2011, Standard Specification for Seamless Copper Tube
- xiv. B88-2014, Standard Specification for Seamless Copper Water Tube
- xv. B584-2014, Standard Specification for Copper Alloy Sand Castings for General Applications
- xvi. B687-1999 (R2011), Standard Specification for Brass, Copper, and Chromium-Plated Pipe Nipples
- xvii. C919-2012, Standard Practice for Use of Sealants in Acoustical Applications
- xviii. D1785-2012, Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
- xix. D2000-2012, Standard Classification System for Rubber Products in Automotive Applications
- xx. D2564-2012, Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems
- xxi. D2657-2007, Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings
- xxii. D2855-1996 (R2010), Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings
- xxiii. D4101-2014, Standard Specification for Polypropylene Injection and Extrusion Materials
- xxiv. E1120-2008, Standard Specification for Liquid Chlorine
- xxv. E1229-2008, Standard Specification for Calcium Hypochlorite
- xxvi. F2389-2010, Standard Specification for Pressure-rated Polypropylene (PP) Piping Systems
- xxvii. F2620-2013, Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings
- xxviii. F2769-2014, Standard Specification for Polyethylene of Raised Temperature (PE-RT) Plastic Hot and Cold-Water Tubing and Distribution Systems
- e. American Water Works Association (AWWA):
 - i. C110-2012, Ductile-Iron and Gray-Iron Fittings
 - ii. C151-2009, Ductile Iron Pipe, Centrifugally Cast
 - iii. C153-2011, Ductile-Iron Compact Fittings
 - iv. C203-2008, Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot Applied
 - v. C213-2007, Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines
 - vi. C651-2014, Disinfecting Water Mains
- f. American Welding Society (AWS):
 - i. A5.8M/A5.8-2011-AMD1, Specification for Filler Metals for Brazing and Braze Welding
- g. International Code Council (ICC):
 - i. IPC-2012, International Plumbing Code
- h. Manufacturers Specification Society (MSS):

- i. SP-58-2009, Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation
 - ii. SP-72-2010a, Ball Valves with Flanged or Butt-Welding Ends for General Service
 - iii. SP-110-2010, Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends
 - i. NSF International (NSF):
 - i. 14-2015, Plastics Piping System Components and Related Materials
 - ii. 61-2014a, Drinking Water System Components – Health Effects
 - iii. 372-2011, Drinking Water System Components – Lead Content
 - j. Plumbing and Drainage Institute (PDI):
 - i. PDI-WH 201-2010, Water Hammer Arrestors
 - k. Department of Veterans Affairs:
 - i. H-18-8-2013, Seismic Design Handbook
- 4. Submittals
 - a. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
 - b. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 22 11 00, FACILITY WATER DISTRIBUTIONS", with applicable paragraph identification.
 - c. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
 - d. Complete operating and maintenance manuals including wiring diagrams, technical data sheets and information for ordering replacement parts:
 - i. Include complete list indicating all components of the systems.
 - ii. Include complete diagrams of the internal wiring for each item of equipment.
 - iii. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
 - e. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- 5. Quality Assurance
 - a. A certificate shall be submitted prior to welding of steel piping showing the Welder's certification. The certificate shall be current and no more than one year old. Welder's qualifications shall be in accordance with ASME BPVC Section IX.
 - b. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be by the same manufacturer as the groove components.
 - c. All pipe, couplings, fittings, and specialties shall bear the identification of the manufacturer and any markings required by the applicable referenced standards.
 - d. Bio-Based Materials: For products designated by the USDA's Bio-Preferred Program, provide products that meet or exceed USDA recommendations for bio-based content, so long as products meet all performance requirements in this specifications section. For more information regarding the product categories covered by the Bio-Preferred Program, visit <http://www.biopreferred.gov>.
- 6. As Built Documentation
 - a. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
 - b. Submit operation and maintenance data updated to include submittal review comments, substitutions and construction revisions shall be in electronic version on compact disc or DVD and inserted into a three ring binder. All aspects of system operation and maintenance procedures,

including piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices shall be included. A list of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.

- c. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. As-built drawings are to be provided, and a copy of them in Auto-CAD provided on compact disk or DVD. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement.
- d. Certification documentation shall be provided to COR 10 working days prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and certificate if applicable that all results of tests were within limits specified. If a certificate is not available, all documentation shall be on the Certifier's letterhead.

PRODUCTS

7. Materials

- a. Material or equipment containing a weighted average of greater than 0.25 percent lead are prohibited in any potable water system intended for human consumption, and shall be certified in accordance with NSF 61 or NSF 372. Endpoint devices used to dispense water for drinking shall meet the requirements of NSF 61, Section 9.
- b. Plastic pipe, fittings, and solvent cement shall meet NSF 14 and shall be NSF listed for the service intended.

8. Underground Water Service Connections to Buildings

- a. From inside face of exterior wall to a distance of approximately 1500 mm (5 feet) outside of building and underground inside building, material to be the same for the size specified inside the building.
- b. 75 mm (3 inch) Diameter and Greater: Ductile iron, AWWA C151, 2413 kPa (350 psig) pressure class, exterior bituminous coating, and cement lined. Bio-based materials shall be utilized when possible. Provide flanged and anchored connection to interior piping.
- c. Under 75 mm (3 inch) Diameter: Copper tubing, ASTM B88, Type K, seamless, annealed. Fittings are as specified in paragraph "Above Ground (Interior) Water Piping". Use brazing alloys, AWS A5.8M/A5.8, Classification BCuP.
- d. Flexible Expansion Joint: Ductile iron with ball joints rated for 1725 kPa (250 psig) working pressure conforming to AWWA C153, capable of deflecting a minimum of 20 degrees in each direction. Flexible expansion joint size shall match the pipe size it is connected to and shall have the expansion capability designed as an integral part of the ductile iron ball castings. Pressure containing parts shall be lined with a minimum of 15 mils of fusion bonded epoxy conforming to the applicable requirements of AWWA C213 and shall be factory tested with a 1500 volt spark test. Flexible expansion joint shall have flanged connections conforming to AWWA C110. Bolts and nuts shall be 316 stainless steel and gaskets shall be neoprene. The flexible expansion fitting shall not expand or exert an axial thrust under internal water pressure. Provide piping joint restraints at each mechanical

joint end connection and piping restraints at the penetration of the building wall. The restraints shall be provided to address the developed thrust at the change of piping direction.

9. Above Ground (Interior) Water Piping

- a. Pipe: Copper tube, ASTM B88, Type K or L, drawn. For pipe 150 mm (6 inches) and larger, stainless steel, ASTM A312 shall be used.
- b. Fittings for Copper Tube:
 - i. Wrought copper or bronze castings conforming to ASME B16.18 and B16.22. Unions shall be bronze, MSS SP-72, MSS SP-110, solder or braze joints. Use 95/5 tin and antimony for all soldered joints.
 - ii. Grooved fittings, 50 to 150 mm (2 to 6 inch) wrought copper ASTM B75/B75M C12200, 125 to 150 mm (5 to 6 inch) bronze casting ASTM B584, C84400. Mechanical grooved couplings, 2070 kPa (300 psig) minimum ductile iron, ASTM A536 Grade 448-310-12 (Grade 65-45-12), or malleable iron, ASTM A47/A47M Grade 22410 (Grade 32510) housing, with EPDM gasket, steel track head bolts, ASTM A183, coated with copper colored alkyd enamel.
 - iii. Mechanical press-connect fittings for copper pipe and tube shall conform to the material and sizing requirements of ASME B16.51, NSF 61 approved, 50 mm (2 inch) size and smaller mechanical press-connect fittings, double pressed type, with EPDM (ethylene propylene diene monomer) non-toxic synthetic rubber sealing elements and un-pressed fitting identification feature.
 - iv. Mechanically formed tee connection: Form mechanically extracted collars in a continuous operation by drilling pilot hole and drawing out tube surface to form collar, having a height of not less than three times the thickness of tube wall. Adjustable collaring device shall ensure proper tolerance and complete uniformity of the joint. Notch and dimple joining branch tube in a single process to provide free flow where the branch tube penetrates the fitting. Braze joints.
 - v. Flanged fittings, bronze, class 150, solder-joint ends conforming to ASME B16.24.
- c. Fittings for Stainless Steel:
 - i. Stainless steel butt-welded fittings, Type 316, Schedule 10, conforming to ASME B16.9.
 - ii. Grooved fittings, stainless steel, Type 316, Schedule // 10 // // 40 //, conforming to ASTM A403/A403M. Segmentally fabricated fittings are not allowed. Mechanical grooved couplings, ductile iron, 4138 kPa (600 psig), ASTM A536 Grade 448-310-12 (Grade 65-45-12), or malleable iron, ASTM A47/A47M Grade 22410 (Grade 32510) housing, with EPDM gasket, steel track head bolts, ASTM A183, coated with copper colored alkyd enamel.
- d. Adapters: Provide adapters for joining pipe or tubing with dissimilar end connections.
- e. Solder: ASTM B32 alloy type Sb5, HA or HB. Provide non-corrosive flux.
- f. Brazing alloy: AWS A5.8M/A5.8, brazing filler metals shall be BCuP series for copper to copper joints and BAg series for copper to steel joints.
- g. Re-agent Grade Water Piping and Dialysis Water Piping:
 - i. Polypropylene, ASTM F2389, Schedule 80 pressure pipe without additions of modifiers, plasticizers, colorants, stabilizers or lubricants. Bio-based materials shall be utilized when possible. This virgin un-plasticized pipe and fittings shall transport 10 megohm water with no loss of purity. Provide socket or butt end fittings with ASTM D2657 heat fusion joints.
 - ii. Polyethylene, ASTM F2769, Schedule 80, food and medical grade, capable of transporting 10 megohm water with no loss of purity. Processed by continuous compression molding without the addition of fillers, polymer modifiers or processing aids. Uniform color with no cracks, flaws, blisters or other imperfections in appearance. Provide ASTM D2657 or ASTM

F2620 heat fusion butt welded joints. In accordance with manufacturer's recommendations, provide continuous channel support under all horizontal piping.

10. Exposed Water Piping

- a. Finished Room: Use full iron pipe size chrome plated brass piping for exposed water piping connecting fixtures, casework, cabinets, equipment and reagent racks when not concealed by apron including those furnished by the Government or specified in other sections.
 - i. Pipe: ASTM B43, standard weight.
 - ii. Fittings: ASME B16.15 cast bronze threaded fittings with chrome finish.
 - iii. Nipples: ASTM B687, Chromium-plated.
 - iv. Unions: MSS SP-72, MSS SP-110, brass or bronze with chrome finish. Unions 65 mm (2-1/2 inches) and larger shall be flange type with approved gaskets.
- b. Unfinished Rooms, Mechanical Rooms and Kitchens: Chrome-plated brass piping is not required. Paint piping systems as specified in Section 09 91 00, PAINTING.

11. Strainers

- a. Provide on high pressure side of pressure reducing valves, on suction side of pumps, on inlet side of indicating and control instruments and equipment subject to sediment damage and where shown on drawings. Strainer element shall be removable without disconnection of piping.
- b. Water: Basket or "Y" type with easily removable cover and brass strainer basket.
- c. Body: Less than 75 mm (3 inches), brass or bronze; 75 mm (3 inches) and greater, cast iron or semi-steel.

12. Dielectric Fittings

- a. Provide dielectric couplings or unions between pipe of dissimilar metals.

13. Sterilization Chemicals

- a. Hypochlorite: ASTM E1120.
- b. Liquid Chlorine: ASTM E1229.

14. Water Hammer Arrestor

- a. Closed copper tube chamber with permanently sealed 413 kPa (60 psig) air charge above a Double O-ring piston. Two high heat Buna-N O-rings pressure packed and lubricated with FDA approved silicone compound. All units shall be designed in accordance with ASSE 1010. Access shall be provided where devices are concealed within partitions or above ceilings. Size and install in accordance with PDI-WH 201 requirements. Provide water hammer arrestors at:
 - i. All solenoid valves.
 - ii. All groups of two or more flush valves.
 - iii. All quick opening or closing valves.
 - iv. All medical washing equipment.

EXECUTION

15. Installation

- a. General: Comply with the International Plumbing Code and the following:
 - i. Install branch piping for water from the piping system and connect to all fixtures, valves, cocks, outlets, casework, cabinets and equipment, including those furnished by the Government or specified in other sections.
 - ii. Pipe shall be round and straight. Cutting shall be done with proper tools. Pipe, except for plastic and glass, shall be reamed to remove burrs and a clean smooth finish restored to full pipe inside diameter.

- iii. All pipe runs shall be laid out to avoid interference with other work/trades.
- iv. Install union and shut-off valve on pressure piping at connections to equipment.
- v. Pipe Hangers, Supports and Accessories:
 1. All piping shall be supported per the IPC, H-18-8 Seismic Design Handbook, MSS SP-58, and SMACNA as required.
 2. Shop Painting and Plating: Hangers, supports, rods, inserts and accessories used for pipe supports shall be shop coated with zinc chromate primer paint. Electroplated copper hanger rods, hangers and accessories may be used with copper tubing.
 3. Floor, Wall and Ceiling Plates, Supports, Hangers:
 - a. Solid or split un-plated cast iron.
 - b. All plates shall be provided with set screws.
 - c. Pipe Hangers: Height adjustable clevis type.
 - d. Adjustable Floor Rests and Base Flanges: Steel.
 - e. Concrete Inserts: "Universal" or continuous slotted type.
 - f. Hanger Rods: Mild, low carbon steel, fully threaded or Threaded at each end with two removable nuts at each end for positioning rod and hanger and locking each in place.
 - g. Pipe Hangers and Riser Clamps: Malleable iron or carbon steel. Pipe Hangers and riser clamps shall have a copper finish when supporting bare copper pipe or tubing.
 - h. Rollers: Cast iron.
 - i. Self-drilling type expansion shields shall be "Phillips" type, with case hardened steel expander plugs.
 - j. Hangers and supports utilized with insulated pipe and tubing shall have 180 degree (minimum) metal protection shield centered on and welded to the hanger and support. The shield thickness and length shall be engineered and sized for distribution of loads to preclude crushing of insulation without breaking the vapor barrier. The shield shall be sized for the insulation and have flared edges to protect vapor-retardant jacket facing. To prevent the shield from sliding out of the clevis hanger during pipe movement, center-ribbed shields shall be used.
 - k. Miscellaneous Materials: As specified, required, directed or as noted on the drawings for proper installation of hangers, supports and accessories. If the vertical distance exceeds 6.1 m (20 feet) for cast iron pipe additional support shall be provided in the center of that span. Provide all necessary auxiliary steel to provide that support.
 - l. With the installation of each flexible expansion joint, provide piping restraints for the upstream and downstream section of the piping at the flexible expansion joint. Provide calculations supporting the restraint length design and type of selected restraints. Restraint calculations shall be based on the criteria from the manufacturer regarding their restraint design.
 4. Install chrome plated cast brass escutcheon with set screw at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.
 5. Penetrations:

- a. Firestopping: Where pipes pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke, and gases as specified in Section 07 84 00, FIRESTOPPING. Completely fill and seal clearances between raceways and openings with the firestopping materials.
 - b. Waterproofing: At floor penetrations, completely seal clearances around the pipe and make watertight with sealant as specified in Section 07 92 00, JOINT SEALANTS. Bio-based materials shall be utilized when possible.
 6. Mechanical press-connect fitting connections shall be made in accordance with the manufacturer's installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. Ensure the tube is completely inserted to the fitting stop (appropriate depth) and squared with the fitting prior to applying the pressing jaws onto the fitting. The joints shall be pressed using the tool(s) approved by the manufacturer. Minimum distance between fittings shall be in accordance with the manufacturer's requirements. When the pressing cycle is complete, visually inspect the joint to ensure the tube has remained fully inserted, as evidenced by the visible insertion mark.
 - vi. Domestic Water piping shall conform to the following:
 1. Grade all lines to facilitate drainage. Provide drain valves at bottom of risers and all low points in system. Design domestic hot water circulating lines with no traps.
 2. Connect branch lines at bottom of main serving fixtures below and pitch down so that main may be drained through fixture. Connect branch lines to top of main serving only fixtures located on floor above.
16. Tests
- a. General: Test system either in its entirety or in sections. Submit testing plan to COR 10 working days prior to test date.
 - b. Potable Water System: Test after installation of piping and domestic water heaters, but before piping is concealed, before covering is applied, and before plumbing fixtures are connected. Fill systems with water and maintain hydrostatic pressure of 1035 kPa (150 psig) gage for two hours. No decrease in pressure is allowed. Provide a pressure gage with a shutoff and bleeder valve at the highest point of the piping being tested. Pressure gauge shall have 1 psig increments.
 - c. Re-agent Grade Water Systems: Fill system with water and maintain hydrostatic pressure of 1380 kPa (200 psig) gage during inspection and prove tight.
 - d. All Other Piping Tests: Test new installed piping under 1-1/2 times actual operating conditions and prove tight.
 - e. The test pressure shall hold for the minimum time duration required by the applicable plumbing code or authority having jurisdiction.
17. Sterilization
- a. After tests have been successfully completed, thoroughly flush and sterilize the interior domestic water distribution system in accordance with AWWA C651.
 - b. Use liquid chlorine or hypochlorite for sterilization.
18. Commissioning
- a. Provide commissioning documentation in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

- b. Components provided under this section of the specification will be tested as part of a larger system.
19. Demonstration and Training
- a. Provide services of manufacturer's technical representative for four hours to instruct VA Personnel in operation and maintenance of the system.
 - b. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

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1. GENERAL

a. DESCRIPTION

- i. Domestic water pressure booster system.
- ii. A complete listing of all acronyms and abbreviations are included in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING

b. RELATED WORK

- i. Section 01 00 00, GENERAL REQUIREMENTS
- ii. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES
- iii. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS
- iv. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS
- v. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING
- vi. Section 22 05 12, GENERAL MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT
- vii. Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS: Requirements for commissioning, systems readiness checklist, and training
- viii. Section 26 29 11, MOTOR CONTROLLERS

c. APPLICABLE PUBLICATIONS

- i. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- ii. American Society of Mechanical Engineers (ASME)
 1. ASME Boiler and Pressure Code
 - a. BPVC Section VIII-1-2015, Rules for Construction of Pressure Vessels, Division 1
 - b. BPVC Section VIII-2-2015, Rules for Construction of Pressure Vessels, Division 2-Alternative Rules
- iii. American Society for Testing and Materials (ASTM)
 1. A48/A48M-2003 (R2012), Standard Specification for Gray Iron Castings
 2. B584-2014, Standard Specification for Copper Alloy Sand Castings for General Applications
- iv. International Code Council (ICC)
 1. IPC-2012, International Plumbing Code
- v. National Electrical Manufacturers Association (NEMA)
 1. ICS 6-1993 (R2001, R2006), Industrial Control and Systems: Enclosures
 2. 250-2014, Enclosures for Electrical Equipment (1000 Volts Maximum)
- vi. NSF International (NSF)
 1. 61-2014a, Drinking Water System Components – Health Effects
 2. 372-2011, Drinking Water System Components – Lead Content
- vii. Underwriters' Laboratories, Inc. (UL)
 1. 508-1999 (R2013), Standards for Industrial Control Equipment
 2. 778-2010 (R2014), Standard for Motor-Operated Water Pumps

d. SUBMITTALS

- i. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- ii. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 22 11 23, DOMESTIC WATER PUMPS", with applicable paragraph identification.

- iii. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
 - 1. Pump:
 - a. Manufacturer and model.
 - b. Operating speed.
 - c. Characteristic performance curves.
 - 2. Motor:
 - a. Manufacturer, frame and type.
 - b. Speed.
 - c. Current Characteristics.
 - d. Efficiency.
 - 3. Tank:
 - a. Manufacturer and model.
 - b. Capacity.
 - 4. Drive: Information in accordance with Section 26 29 11, MOTOR CONTROLLERS
 - iv. Certificate of shop test for domestic water booster system. Provide certified performance curves.
 - v. Certified copies of all the factory and construction site test data sheets and reports.
 - vi. Complete operating and maintenance manuals including wiring diagrams, technical data sheets, information for ordering replacement parts, and troubleshooting guide.
 - 1. Include complete list indicating all components of the systems.
 - 2. Include complete diagrams of the internal wiring for each item of equipment.
 - 3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
 - vii. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- e. QUALITY ASSURANCE
- i. General:
 - 1. UL Compliance: Comply with UL 778 for motor-operated water pumps.
 - 2. Design Criteria:
 - a. UL Compliance: Comply with UL 778 for motor-operated water pumps.
 - b. Head-capacity curves shall slope up to maximum head at shut-off. Select pumps near the midrange of the curve, and near the point of maximum efficiency, without approaching the pump curve end point and possible cavitation and unstable operation. Select pumps for open systems so that required net positive suction head (NPSHR) does not exceed the net positive head available (NPSHA).
 - c. Pump Driver: Furnish with pump. Size shall be non-overloading at any point on the head-capacity curve, including in a parallel or series pumping installation with one pump in operation.
 - d. Provide all pumps with motors, impellers, drive assemblies, bearings, coupling guard and other accessories specified. Statically and dynamically balance all rotating parts.
 - e. Furnish each pump and motor with a nameplate giving the manufacturers name, serial number of pump, capacity in GPM and head in feet at design

- condition, horsepower, voltage, frequency, speed and full load current and motor efficiency.
- f. Test all pumps before shipment. The manufacturer shall certify all pump ratings.
 - g. After completion of balancing, provide replacement of impellers or trim impellers to provide specified flow at actual pumping head, as installed.
- ii. Domestic Water Pressure Booster System
 - 1. Components shall be furnished by a single manufacturer and the system shall be the standard cataloged product of the manufacturer.
 - 2. Shop Test: Water booster unit and its component parts shall undergo a thorough electric and hydraulic operating test prior to shipment. Tests shall include a system operating flow test from zero to 100 percent of design flow rate under specified suction and system pressure conditions. Certified performance curves shall be furnished.
 - iii. Bio-Based Materials: For products designated by the USDA's Bio-Preferred Program, provide products that meet or exceed USDA recommendations for bio-based content, so long as products meet all performance requirements in this specifications section. For more information regarding the product categories covered by the Bio-Preferred Program, visit <http://www.biopreferred.gov>.
- f. AS BUILT DOCUMENTATION
 - i. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
 - ii. Submit operation and maintenance data updated to include submittal review comments, substitutions and construction revisions shall be in electronic version on compact disc or DVD and inserted into a three ring binder. All aspects of system operation and maintenance procedures, including piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices such as damper and door closure interlocks shall be included. A List of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.
 - iii. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. As-built drawings are to be provided, and a copy of them in Auto-CAD provided on compact disk or DVD. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement.
 - iv. Certification documentation shall be provided to COR 10 working days prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and certification that all results of tests were within limits specified.
2. DOMESTIC WATER PRESSURE BOOSTER SYSTEM

- a. Material or equipment containing a weighted average of greater than 0.25 percent lead shall be prohibited in any potable water system intended for human consumption, and shall be certified in accordance with NSF 61 or NSF 372.
- b. General: Provide a factory prefabricated, prewired and pretested multi-stage pumping system including variable speed drive motors, pressure regulating valves with integral check valves, pressure transducers, vibration pads, emergency switches, duplex flow switches, power and control panels, suction and discharge manifolds, butterfly isolation valves, ball drain valves, bypass loops with appropriate valves and check valves, low pressure cut-off switches, hydropneumatic tanks and accessories. All components shall be furnished by a single manufacturer and the system shall be the standard cataloged product of the manufacturer. All components shall be factory installed on a common structural steel skid and shall be completely tested in the factory before shipment. Manufacturer shall assume "unit responsibility" to ensure that all components effectively interface to execute the operation of the designed system.
- c. System Operation and Configuration:
 - i. The booster system shall be factory assembled on a steel skid including pumps, motors, valves, (SCH40 steel hot-dip galvanized after fabrication) (type "L" copper) (SCH10 300 series stainless steel) suction and discharge manifolds, and all interconnecting piping, wiring and controls. Manifold connections will be (grooved) (flanged) at one end. Branch piping and tank piping (if applicable) shall be the same material as the suction and discharge manifolds. Provide isolation valves on the suction and discharge of each pump. The valves shall be (full-port ball valves) (lug style butterfly valves). Provide a thermal purge valve on the discharge of each pump. Provide two 4 1/2" ASME grade A, panel mounted gauges for indicating system suction and system discharge pressure. All skid mounted components shall be factory finished in a high quality enamel paint. Individual pumps, motors and pressure regulating or check valves may be serviced with the booster system in operation and all components shall be suitable for the maximum working pressure and temperature in the system.
 - ii. System pumps shall include three multi-stage vertical centrifugal pumps with ANSI flanged connections. The pump suction/discharge chamber, motor stool and pump shaft coupling shall be constructed of cast iron. The impellers, pump shaft, diffuser chambers, outer discharge sleeve and impeller seal rings or seal ring retainers shall be constructed of stainless steel. Intermediate and lower shaft bearings shall be bronze or tungsten carbide and ceramic. Pumps shall be equipped with a mechanical seal assembly with tungsten carbide seal faces mounted in stainless steel seal components. The pump motor shall be NEMA C face design mounted directly to the top of the pump. Pump No. 1, Pump No. 2 and Pump No. 3 shall be rated 227 GPM at 150 ft head.
 - iii. Pump motors shall be 460 volt, 3 phase, 60 Hz totally enclosed fan cooled and manufactured in accordance with NEMA standards. Pump No. 1, Pump No. 2 and Pump No. 3 shall be 15 HP, 3500 RPM. Motors shall be selected so that they do not exceed nameplate HP rating throughout the programmed sequence of pump operation.
 - iv. System valves, each pump discharge shall have a wafer style silent non-slam check valve with cast iron body and sized for a maximum loss of 3 PSI at design flow and be suitable for the maximum working pressure of the system.
 - v. Provide a hydro-pneumatic tank with a carbon steel shell and a replaceable F.D.A. approved heavy duty bladder to separate the air and water. No water shall come in contact with the metal walls of the tank. Features shall include an air fill valve and bottom system connection

suitable for 100% drawdown. The tank must be suitable for a maximum working pressure of 150 PSIG with a volume of 125 to 132 gallons. The tank must be suitable for a maximum working pressure of 150 PSIG with a volume of 125 to 132 gallons.

- vi. Provide and mount on the system skid three variable frequency drives of the PWM design suitable for variable torque applications using any standard NEMA Design B squirrel cage induction motor. Variable frequency drives shall be sized for the maximum possible amp draw throughout the programmed sequence of pump operation.
- vii. Pulse width modulated, starts into a rotating load. Keypad operator device including the following: two line backlit LCD display, power on and alarm/fault displays, in auto the drive follows signal from logic section of control panel, hand/off/auto switch and manual speed adjustment, auto drive shutdown for electrical fault, automatic restart after power fails shutdown. Operational data displays include: drive speed (HZ), motor power energy (kWh), current, elapsed time, RPM, motor voltage, complete service diagnostics with fault history log. The efficiency at full load and full speed will be 97% with a fundamental power factor of .98.
- viii. Provide one pressure sensor/transmitter that provides a 4 to 20 mA DC output, compatible with the system controls, temperature and pressure requirements. Pressure sensor/transmitter shall have zero, span and damping devices. The transmitter shall be installed on the system discharge header and factory wired to the control panel.
- ix. The lead pump shall run only as necessary to maintain system pressure and will be controlled automatically by means of a pressure sensor/transmitter and programmable logic controller (PLC) programmed to prevent short cycling. If the lead pump is unable to maintain system pressure the lag pump(s) will be called on after a time delay and will operate in parallel with the lead pump in accordance with the PLC program. When one pump can handle the system demand the controls will shut down the lag pump(s). When a low or no flow condition is reached, the controls will accelerate the lead pump to charge the system and hydro-pneumatic tank then shut the lead pump down and alternate.
- x. Provide, mount and wire on the skid a programmable logic controller in an enclosure to interface the signal from the pressure sensor to the VFD's and provide a stabilized response to speed up or slow down the pump or add the lag pump(s) to meet system requirements. The controller shall provide setpoint adjustment, timer adjustment, PID functions and both system and controller self-diagnostics via a 2 line 20 character display with keypad (5.7" STN touchscreen display). All user interface setpoints are easily accessible via the password protected display screen. Normal system operation is tuned to eliminate hunting. Controller shall have one RS 485 Communication port, real time calendar/clock and EEPROM memory transfer cartridge.
- xi. Each system shall include a UL listed enclosed industrial control panel in a NEMA 1 (NEMA 12, 3R) enclosure, factory mounted and wired on the steel skid. The panel shall be furnished with individual pump disconnects with through the door handles, pump run lights, H-O-A selector switches and 115 volt fused control transformer.
- xii. UL listed enclosed industrial control panel; individual fused disconnects with external handle; programmable logic controller (PLC); pump running lights; H/O/A selector switches; 115 volt fused control circuit transformer; pump minimum run timers; mounted and wired on skid; pump operating and sequence controls; control power (on-off) switch and light; low suction pressure shutdown circuit with auto reset and light; high suction pressure shutdown circuit with auto reset, delay timer and light; high suction pressure shutdown circuit with

manual reset and light; audible alarm with silence push button; auto alternate (3) equal pumps; 24 hour time clock – alternate (2) equal pumps' 7 day time clock for continuous system operation; flow switch to limit lead pump on-off cycling; elapsed time meters; auxiliary relay contacts; key lockable enclosure.

- xiii. The booster system shall be hydrostatically tested and shall undergo a complete electric and hydraulic test from 0 to 100% design flow at the factory. All control devices including transmitters and all safety features shall be factory calibrated and tested. The owner's representative may witness the test.
- xiv. The booster system shall be warranted in writing against defects in materials or workmanship under normal use and service for a period of one year after date of original operation but not more than 18 months from date of shipment from the Company's factory when installed and used in accordance with good standard practice.

3. EXECUTION

a. Startup and Testing

- i. Make tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.
- ii. System Test: After installation is completed provide an operational test of the completed system including flow rates, pressure compliance, alarms and all control functions.
- iii. When any defects are detected, correct defects and repeat test at no additional cost or time to the Government.
- iv. A VA Engineering Representative will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the COR and VA Engineering Representative. Contractor shall provide a minimum of 10 working days prior to startup and testing.

b. Commissioning

- i. Provide commissioning documentation in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- ii. Components provided under this section of the specification will be tested as part of a larger system.

c. Demonstration and Training

- i. Provide services of manufacturer's technical representative for four hours to instruct VA Personnel in operation and maintenance of the system.
- ii. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

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