SECTION 22 00 00 - GENERAL PLUMBING REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Specification requirements defined in Division 22 of this Specification apply to, and are in addition to the work associated with equipment, systems, materials, and installation requirements specified in Division 23. Contractor shall provide the requirements specified in Division 22 to obtain complete systems, tested, adjusted, and ready for operation.

B. All Fixtures, Equipment, and Valves locations shall be designed and Installed to be Accessible, Readily (Readily Accessible). Capable of being reached quickly for operation, renewal, or inspections without requiring those to whom ready access is requisite to take actions such as to use tools (other than keys), to climb over or under, to remove obstacles, or to resort to portable ladders, and so forth.

1.2 RELATED WORK

A. Division 01 - General Requirements
B. Section 07-84-00 - Firestopping
C. Division 21 - Fire Suppression
D. Division 23 - Heating Ventilation and Air Conditioning HVAC
E. Division 25 - Integrated Automation
F. Division 26 - Electrical
G. Division 33 – Utilities
H. Campus Standard Details - 3000 - Drainage
I. Campus Standard Details - 6000 - Utilities

PART 2 - PRODUCTS

2.1 Not Applicable to this Section.

PART 3 - EXECUTION

3.1 Not Applicable to this Section.

END OF SECTION 22 00 00

SECTION 22 05 00 – COMMON WORK RESULTS FOR PLUMBING

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. General Design Information

1. Following is a brief description of the features which should be incorporated in the specifications for various plumbing materials and equipment. Where a specific product is stated with model number, that product should be used as the basis of design and listed as the first named in the specifications. Manufacturers listed without model number are intended to give the designer input on manufacturers whose products have been found to be acceptable.

2. All Fixtures, Equipment, and Valve locations shall be designed to be Accessible, Readily (Readily Accessible). Capable of being reached quickly for operation, renewal, or inspections without requiring those to whom ready access is requisite to take actions such as to use tools (other than keys), to climb over or under, to remove obstacles, or to resort to portable ladders, and so forth.

B. General Quality Level:

1. Generally, plumbing material and equipment selected should be institutional grade. Long life and simple low-cost maintenance are critical attributes for nearly all University projects. Plumbing fixtures in public areas should also be selected to endure rough use and daily janitorial cleaning.

C. General-Duty Valves Requirements:

1. Isolation Valves: Provide sufficient number of valves for ease of service, and to reduce inconvenience to users due to outages and draining of systems for minor repairs.

2. Ball valve: Provide with stainless steel ball and stem from and from ½"-1.5" and from 2" up either bronze gate valve or epoxy coated resilient wedge iron body gate valve.

3. Relief valves: Daylight to a conspicuous location. Plumb to sewer.
4. All Fixtures Valves shall be installed to be Accessible, Readily (Readily Accessible). Capable of being reached quickly for operation, renewal, or inspections without requiring those to whom ready access is requisite to take actions such as to use tools (other than keys), to climb over or under, to remove obstacles, or to resort to portable ladders, and so forth.

D. Identification for Plumbing Piping and Equipment Requirements:

1. Identification Charts: Location should be reviewed and approved by Project Manager in consultation with Facility Services.

2. Piping Service: Identification Tags: Provide with abbreviated legend on 1st line and pipe size on 2nd line. Locate to be visible from exposed points of observation. Where 2 or more pipes run parallel, place printed legend and other markers in same relative location.

3. Valves Service Identification Tags: Provide with abbreviated legend on 1st line and valve service chart number on 2nd line. Identification Charts: Provide two (2) satin finished extruded aluminum frames with rigid clear plastic glazing; 8-1/2 x 11 inches, minimum for each chart. In addition, provide electronic copy of each chart.

E. Keys for Cabinets and Padlocks:

1. Cabinets and Equipment: Provide 2 keys per panel. Coordinate with Section 08 06 05 - Key Schedule.

2. Padlocks: Coordinate with Section 08 06 05 - Key Schedule.
3. Closeout Submittal: Provide panel keys separated and labeled. Provide location, room number, quantity, manufacturer name and model numbers of keys, and coordinate closeout submittal with Section 08 06 05 - Key Schedule.

F. Testing

1. All new piping shall be tested prior to tie in to existing systems.
2. Do not test against existing valves when connecting into an existing system. Provide a slip blind at the valve flange or other suitable isolation.
3. Test gauges shall have 3' minimum dial, with oil fill and gauge cock. Gauge calibration shall be verified to the satisfaction of the University's Inspector prior to commencing testing.
4. Domestic and Industrial Hot & Cold-Water Piping
5. 150 PSIG test line pressure when connecting to existing system within an existing building for a period of 4 hours using a test medium of water.
6. 200 PSIG test pressure for a period of 4 hours using a test medium of water for portions of the system which serve both the fire suppression system and the domestic water.
7. Drain, Waste & Vent Piping Including Lab Waste: 10 feet of head for a period of 1 hour using a test medium of Water.
8. Natural Gas Piping: 50 PSIG test pressure for a period of 4 hours using a test medium of air.
9. Compressed Air Piping: 150 PSIG test pressure for a period of 4 hours using a test medium of air.
10. Pure Water Piping Systems: 100 PSIG test pressure fora period of 4 hours using a test medium of purified water. See 22 05 19 Meters and Gages for Plumbing Piping
    a. Water meters for domestic water should be nutating disk type sufficiently accurate to record the lowest expected flow (typically the flush of a single low flush toilet). Provide compound metering if necessary to accommodate a large range of flows.
    b. Provide a permanently piped full size meter bypass on all domestic water services 3" and larger. Valving should be arranged so that the meter can be removed without a disruption of water service.
    c. All water meters should record in cubic feet.
    d. Meters for irrigation may be either nutating disk or turbine type depending on expected flow.

PART 2 - PRODUCTS

2.1 Not Applicable to this Section.

PART 3 - EXECUTION

3.1 Not Applicable to this Section.

END OF SECTION 22 05 00

SECTION 22 05 48 - VIBRATION, NOISE AND SEISMIC CONTROLS FOR PLUMBING EQUIPMENT AND PIPING

<NOTE TO REVIEWER: ALL COLORED AND BRACKETED TEXT SHOULD BE REVIEWED, EDITED, AND CONVERTED TO BLACK TEXT PRIOR TO PUBLICATION OF THESE SPECIFICATIONS>

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. In the event of conflict regarding mechanical vibration control requirements between this Section and any other Section, the most conservative provision shall govern.

1.2 COMMISSIONING <EDIT OR DELETE AS APPROPRIATE>

A. Comply with the requirements of Specification Section 01 91 13 COMMISSIONING REQUIREMENTS for the commissioning of the various building systems.

1.3 SUMMARY

A. This Section specifies the requirements for vibration control systems to be used in all phases of mechanical work.

B. This Specification provides the necessary design for the avoidance of excessive vibration in the building due to the operation of machinery or equipment and/or due to interconnected piping, conduit, or structures.

C. Due to the nature of this facility the design criteria may exceed those of normal industrial construction. It is imperative that close attention be paid to all specifications and details for noise and vibration control.

D. This Section includes the following:

1. Isolation pads.
2. Isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Spring isolators.
5. Elastomeric hangers.
6. Spring hangers.
7. Pipe riser resilient supports.
8. Resilient pipe guides.
9. Seismic snubbers.
10. Restraining braces and cables.
11. Vibration isolation equipment bases.

1.4 DEFINITIONS

A. IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

D. Accessible: Readily (Readily Accessible). Capable of being reached quickly for operation, renewal, or inspections without requiring those to whom ready access is requisite to take actions such as to use tools (other than keys), to climb over or under, to remove obstacles, or to resort to portable ladders, and so forth.

1.5 RELATED WORK

A. This Section shall be in conjunction with the following specifications and related Contract Documents to establish the total requirements for mechanical vibration control.

1. Section 22 00 00 – Basic Plumbing Requirements
2. Table 22 05 48 – Vibration Isolation Schedule, **[as attached at the end of this Section][as shown in the drawings].**

1.6 CONTRACTOR'S GENERAL RESPONSIBILITIES

A. The Contractor shall bring to the Architect's attention prior to installation any conflicts which will result in unavoidable contact between the building structure and the isolated equipment, piping, etc., described herein, due to inadequate space, etc. Corrective work necessitated by conflicts after installation shall be at the expense of the responsible contractor.

B. The Contractor shall bring to the Architect's attention prior to installation any discrepancies between the requirements of this Specification and field conditions, changes required due to specific equipment selection, etc. Corrective work necessitated by discrepancies after installation shall be at the expense of the responsible contractor.

1.7 DESIGN AND INSTALLATION CRITERIA

A. Equipment, piping and conduit shall not be installed which makes rigid contact with the structure or rigidly-connected building components unless it is allowed by this specification.

B. Pipe Anchors and Supports: Piping supports and anchors shall not interfere with free operation of vibration isolation systems.

C. Systems, equipment, or parts which generate uncharacteristically high levels of noise or vibration while in operation, shall be (1) adjusted, repaired, or replaced as appropriate to obtain acceptable levels of vibration or noise, or (2) be supported on, or fitted with, suppression or absorption devices, or other means, which effectively prevent the transmission of vibration or noise beyond the offending item.

D. Resilient Wall, Ceiling, and Floor Penetrations: Provide resilient wall and ceiling penetrations for all isolated piping, conduit, etc. Provide resilient sealant to maintain the sound transmission characteristics of acoustically rated partitions. Refer to resilient penetration details on the Drawings.

E. Pipe a flow velocities: The following guidelines for flow velocity shall be followed, unless superseded by the more stringent requirements of other specifications.

1. Maximum liquid flow velocities anywhere shall not exceed 9 fps (3 m/s)

1.8 COORDINATION

A. The Work under this Section must be coordinated with all other mechanical, electrical, architectural, and structural work in order to accomplish the interfacing necessary to provide a complete and operating system in conformance with the requirements of the Contract Documents.

1.9 PERFORMANCE REQUIREMENTS <THIS SECTION SHOULD BE FILLED OUT BY THE PROJECT'S STRUCTURAL ENGINEER>

A. Contractor shall comply with the following design characteristics:

1. Site Class as Defined in the IBC.
2. Assigned Seismic Use Group or Building Category as Defined in the IBC
   a. Component Importance Factor:
   b. Component Response Modification Factor:
   c. Component Amplification Factor:
3. Design Spectral Response Acceleration at Short Periods (0.2 Second):
4. Design Spectral Response Acceleration at 1-Second Period:

1.10 SUBMITTALS

A. Provide the following in addition to the standard requirements:

1. A general statement of materials and methods intended for use on this project. Specific information shall be provided for all items described under the products section of this Section. Complete specifications, descriptive drawings, catalog cuts, and descriptive literature, which shall include make, model, dimensions, weight and interface description with other work, shall be supplied. Complete performance data are required that shall indicate full compliance with specifications as outlined.
2. Complete detailed shop drawings showing the intended locations and construction features of all types of products specified. Shop drawings shall be submitted in a timely manner.
3. Catalog cutsheets and data sheets on specific vibration isolators shall be provided showing compliance with the specification.
4. Detailed selection data for each vibration isolator supporting equipment or piping, including:
   a. The equipment identification mark.
   b. The isolator type and model number.
   c. The actual operating load at each support point including all support equipment, piping, and thrust loads.
   d. The static deflection expected under the actual operating load.
   e. The specified minimum static deflection.
   f. The additional deflection to solid under operating load.
   g. The ratio of spring height under actual operating load to spring diameter.

5. Drawings showing equipment frame construction for each machine, including dimensions, structural member sizes, and support point locations.
6. Written approval of the frame design to be used shall be obtained from the equipment manufacturer.
7. Drawings showing methods for suspension, of support, and guides.
8. Drawings showing methods for isolation of piping at penetrations of walls, slabs, and beams.
9. Product data to illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
    a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by [**an evaluation service member of ICC-ES**] [**an agency acceptable to authorities having jurisdiction**].
    b. Annotate to indicate application of each product submitted and compliance with requirements.
10. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined operating loads.

B. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic and wind forces required to select vibration isolators, seismic and wind restraints, and for designing vibration isolation bases.
    a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Division 22 Sections for equipment mounted outdoors.
2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
3. Seismic and Wind Restraint Details:
    a. Design Analysis: To support selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.
    b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
    c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with

requirements in other Division 22 Sections for equipment mounted outdoors.

d. Preapproval and Evaluation Documentation: By [**an evaluation service member of ICC-ES**] [**an agency acceptable to authorities having jurisdiction**], showing maximum ratings of restraint items and the basis for approval (tests or calculations).

C. Coordination Drawings: Show coordination of seismic bracing of piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.

D. Welding certificates.

E. Qualification Data: For [**professional engineer**] [**and**] [**testing agency**].

F. Field quality-control test reports.

1.11 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

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

D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

A. Acceptable Manufacturers: Subject to compliance with requirements, all products shall be supplied by one of the following approved manufacturers or manufacturers that meet all of the requirements of this spec:

1. Kinetics Noise Control Inc. (Kinetics), Dublin, Ohio.
2. Mason Industries, Inc. (Mason), Hauppauge, New York.
3. The VMC Group (V.M.C.), Bloomingdale, New Jersey.

B. General:

1. Metal parts of vibration-isolation units shall be treated per manufacturer's specifications for corrosion resistance (e.g. galvanized, epoxy coated, painted, etc.) and in accordance with other Specification Sections.
2. Elastomeric isolators may be composed of natural rubber or neoprene. Natural rubber shall be used unless this material is incompatible with the installation environment.
3. All isolators installed outdoors shall have base plates with bolt holes for fastening the isolators to the support members.
4. Isolator types are scheduled to establish minimum standards. At the Contractor's option, labor-saving accessories can be an integral part of isolators supplied to provide initial lift of equipment to operating height, hold piping at fixed elevation during installation and initial system filling operations, and similar installation advantages. Accessories shall not degrade the vibration isolation system.
5. Static deflection of isolators shall be as indicated **[in Table 22 05 48 – Vibration Isolation Schedule] [at the end of this section] [in the Mechanical Schedules].** All static deflections stated are the minimum acceptable deflection for the mounts under actual operating load.
6. The use of housed springs, nested springs or of multiple parallel springs within a single mount is not permitted.

C. Type FSN (Free-standing Floor Spring):

1. Spring isolators shall be free-standing and laterally stable without any housing. Spring diameter shall be not less than 0.8 times the compressed height of the spring at the design load. Springs shall have a minimum additional travel to solid approved equal to 50 percent of the actual deflection. Springs shall be designed so that the ratio of horizontal stiffness to vertical stiffness is approximately 1. All mounts shall have leveling bolts.
2. The spring element in the isolator shall be mounted on a Type DNP isolator. A rectangular bearing plate of appropriate size to load the pad uniformly within the manufacturer's range shall be provided. If the spring isolator is supplied with an elastomeric friction pad, a stainless steel, aluminum, or galvanized steel plate shall be used between the friction pad and the DNP isolator.
3. If the isolator is to be fastened to the building structure and a Type DNP isolator is used under the bearing plate, elastomeric grommets shall be provided for each bolt hole in the base plate. Bolt holes shall be properly sized to allow for grommets. Hold down bolt assembly shall include washers to distribute load evenly to the grommet. Bolts and washers shall be galvanized.
4. Type FSN isolators shall be one of the following products, or approved equal, with the appropriate elastomeric pad selected from Type DNP:
   a. Model SLF, SLFH: by Mason
   b. Model FDS: by Kinetics
   c. Model AC, ACB, ADC, ADCB, AWHC: by V.M.C.

D. Type FSNTL (Travel Limited Free-standing Floor Spring):

1. Spring isolators shall be free-standing and laterally stable without any housing. Spring diameter shall be not less than 0.8 times the compressed height of the spring at the

design load. Spring shall have a minimum additional travel to solid approved equal to 50 percent of the actual deflection. Springs shall be designed so that the ratio of horizontal stiffness to vertical stiffness is approximately 1. All mounts shall have leveling bolts. All mounts shall have vertical travel limit stops to control extension when weight is removed. The travel limit stops shall be capable of serving as a structural support during erection of the equipment. A minimum clearance of 1/4 inch (6 mm) shall be maintained around restraining bolts and between the limit stops and the spring to avoid interference with the spring action.

2. The spring element in the isolator shall be mounted on a type DNP isolator. A rectangular bearing plate of appropriate size to load the pad uniformly within the manufacturer's range shall be provided. If the spring isolator is supplied with an elastomeric friction pad, a stainless steel, aluminum, or galvanized steel plate shall be used between the friction pad and the DNP isolator.

3. If the isolator is to be fastened to the building structure and a Type DNP isolator is used under the bearing plate, elastomeric grommets shall be provided for each bolt hole in the base plate. Bolt holes shall be properly sized to allow for grommets. Hold down bolt assembly shall include washers to distribute load evenly to the grommet. Bolts and washers shall be galvanized.

4. Type FSNTL isolators shall be one of the following products, or approved equal, with the appropriate elastomeric pad selected from Type DNP:

   a. Model SLR (welded restraint type): by Mason

   b. Model FLS: by Kinetics

   c. Model AWRS: by V.M.C.

E. Type FN (Elastomer-in-shear Floor Isolator):

1. Elastomeric isolators shall be elastomer-in-shear type with steel reinforced top and base. All metal surfaces shall be covered with elastomer. The top and bottom surfaces shall be ribbed. Bolt holes shall be provided in the base and the top shall have a threaded fastener.

2. The mounts shall include leveling bolts that may be rigidly connected to the equipment.

3. Type FN isolators shall be one of the following products or approved equal:

   a. Model ND: by Mason

   b. Model RD: by Kinetics

   c. Model R/RD: by V.M.C.

F. Type NP (Elastomeric Pad)

1. Elastomeric pad isolators shall be one layer of 1/4-inch (6 mm) to 3/8-inch (10 mm) thick ribbed or waffled material. Elastomer shall be 30 to 70 durometer. The pads shall be sized so that they achieve a minimum static deflection of 15 percent of the pad thickness under full operating load and shall not be loaded above the manufacturer's recommended maximum load.

2. Type NP isolators shall be one of the following products or approved equal:

a. Model Mini Super W: by Mason

b. Model NPS or NPD: by Kinetics

c. Model Shear-Flex: by V.M.C.

G. Type DNP (Double Elastomeric Pad):

1. Elastomeric pad isolators shall be one layer of 3/4-inch (19 mm) thick ribbed or waffled material or formed by two layers of 1/4-inch (6 mm) to 3/8-inch (10 mm) thick ribbed or waffled material. Multiple layers shall be separated by a stainless steel or aluminum plate and shall be permanently adhered together. Elastomeric material shall be 30 to 70 durometer. The pads shall be sized so that they achieve a minimum static deflection of 15 percent of the pad thickness under full operating load and shall not be loaded above the manufacturer's recommended maximum load.

2. Type DNP isolators shall be formed from one of the following products or approved equal:

a. Model Super W or Multiple Layers of W or Mini Super W: by Mason

b. Model RSP or NGS: by Kinetics

c. Model Maxi-Flex or Multiple Layers of Shear Flex: by V.M.C.

H. Type HS (Hanger Spring):

1. Vibration-isolation hangers shall consist of a free-standing laterally stable steel spring set into an elastomeric cup, contained within a steel housing. The elastomeric cup shall be manufactured with a grommet (or other element) to prevent the hanger rod from contacting the hanger housing.

2. Spring diameter and hanger housing hole sizes shall be large enough to permit the hanger rod to swing through a 30-degree arc before contacting the housing. Spring elements shall have minimum additional travel to solid approved equal to 50 percent of the actual deflection.

3. Upper hanger rod attachment shall be made through an elastomeric rubber-in-shear element designed to avoid direct contact between the hanger rod and the isolator frame.

4. Springs shall be color coded for ease of identification.

5. Type HS isolators shall be one of the following products or approved equal:

a. Model 30N: by Mason

b. Model SRH: by Kinetics

c. Model HRSA: by V.M.C.

I. Type HN (Elastomeric Hanger):

1. Vibration-isolation hangers shall consist of an elastomeric-in-shear element contained in a steel housing. An elastomeric neck bushing (or other element) shall be provided where the hanger rod passes through the hanger housing to prevent the rod from contacting the hanger housing. The hangers shall be loaded within the manufacturer’s recommended range.

2. The diameter of the hole in the housing shall be sufficient to permit the hanger rod to swing through a 30-degree arc before contacting the bushing.
3. Type HN isolators shall be one of the following products or approved equal:
   a. Model HD: by Mason
   b. Model RH: by Kinetics
   c. Model HR: by V.M.C.

2.2 VIBRATION ISOLATION EQUIPMENT BASES

A. Acceptable Manufacturers: Subject to compliance with requirements, all products shall be supplied by one of the following approved manufacturers:
   1. Kinetics Noise Control Inc. (Kinetics), Dublin, Ohio.
   2. Mason Industries, Inc. (Mason), Hauppauge, New York.
   3. The VMC Group (V.M.C.), Bloomingdale, New Jersey.

B. Type BSF (Base Steel Frame):
   1. Steel base frames shall consist of structural steel sections sized, spaced, and connected to form a rigid base which will not twist, deform, or deflect in any manner which will negatively affect the operation of the supported equipment or the vibration-isolation mounts.
   2. Frames shall be adequately sized to support basic equipment units and their supports, plus any associated pipe elbow supports, electrical control elements, or other components closely related and requiring resilient support in order to prevent vibration transfer to the building structure. The depth of steel frame bases shall be at least 1/10 of the longest dimension of the base with a minimum depth of 6 inches (150 mm), but not more than 12 inches (300 mm).
   3. Frame bases shall include side mounting brackets for attachment to vibration isolators. Mounting brackets shall be located on the sides of the base that are parallel to the axis of rotation of the supported equipment.
   4. Type BSF base shall be supplied by the isolator manufacturer and shall be one of the following products or approved equal:
      a. Model WFSL: by Mason
      b. Model SFB: by Kinetics
      c. Model WFB: by V.M.C.

C. Type BIB (Base Inertia Base):
   1. Concrete inertia bases shall be formed of stone-aggregate concrete (150 pounds per cubic foot) (2,400 kilograms per cubic meter) and appropriate steel reinforcing cast between perimeter structural steel channels. Inertia bases shall be built to form a rigid base which will not twist, deform, or deflect, in any manner which would negatively affect the operation of the supported equipment or the vibration isolation mounts.

2. Inertia bases shall be adequately sized to support basic equipment units and motors plus any associated pipe elbow supports, electrical control elements, or other components closely related and requiring resilient support in order to prevent vibration transfer to the building structure. Inertia base depth shall be at least 1/12 of the longest dimension of the inertia base, but not less than 6 inches (150 mm) and not more than 12 inches (300 mm).
3. The weight of the inertia base, as a minimum, shall be approved equal to or greater than that of the total weight of the equipment (including the attached piping and fluids the base is supporting and other applicable static and dynamic loads). In special applications such as reciprocating compressors, the inertia base weight requirement could be higher and shall be calculated on a case-by-case basis.
4. Inertia bases shall include side mounting brackets for attachment to vibration isolators. Mounting brackets shall be located on the sides of the base that are parallel to the axis of rotation of the supported equipment.
5. The steel frame and reinforcement shall be supplied by the vibration isolator manufacturer. Concrete shall be provided by the appropriate Subcontractor.
6. Inertia bases used to support vibration-isolated pumps shall be sized to provide support for pipe elbows and suction diffuser.
7. Frame and reinforcement for Type BIB bases shall be one of the following products or approved equal:
    a. Model KSL or BMK: by Mason
    b. Model CIB-L or CIB-H: by Kinetics
    c. Model WPF or MPF: by V.M.C.

2.3 FLEXIBLE CONNECTORS

A. Flexible Pipe Connections: Flexible pipe connectors shall be fabricated of Kevlar or nylon cord, fabric, and elastomer. Flexible pipe connections shall result in a flexible and highly compliant connection that can allow longitudinal, transverse, and angular movements and provide micro- vibration isolation. The flexible connections shall be selected and specially fitted, if necessary, to suit the system temperature, pressure, and fluid type. Rods or cables, installed with appropriate elastomeric grommets, may be used to control extension of the connector if required by the manufacturer, but shall not inhibit movement necessary to provide sufficient vibration isolation. Flexible pipe connections shall be one of the following products or approved equal:
    1. Model SFDEJ: by Mason
    2. Double Sphere (Model DS): by Metraflex
    3. Model VMT: by V.M.C.
    4. Model FTC: by Kinetics

B. Flexible Conduit Connections: Flexible conduit shall be formed of one continuous length of electro-galvanized spiral-wound steel strip. Liquid-tight flexible conduit shall be formed of

one continuous length of electro-galvanized spiral-wound steel strip, with elastomeric gasket.

2.4 RESILIENT PENETRATION SLEEVE/SEAL

A. Resilient penetration sleeve/seals shall be field fabricated from a pipe or sheet metal section that is no more than 1 inch (25 mm) larger in each dimension than the penetrating element and is used to provide a sleeve through the construction penetrated. The actual penetration shall be no more than 1 inch (25 mm) larger in each dimension than the sleeve. The sleeve shall extend 1 inch beyond the penetrated construction on each side. Seal the gap between the penetration and the sleeve airtight with non-shrinking non-hardening acoustical caulk. The annular space between the sleeve and the penetrating element shall be packed with glass fiber or mineral wool to within 1/4 inch of the end of the sleeve. The remaining 1/4-inch (6 mm) space on each side shall be filled with non-shrinking non-hardening acoustical caulk to form an airtight seal. The penetrating element shall be able to pass through the sleeve without contacting the sleeve.

Adjustments to any vibration isolators may be required in order to accomplish this. Alternatively, a prefabricated sleeve (Mason Industries Type SWS or approved equal) that accomplishes the same result is acceptable. **Coordinate with penetration details shown on the Drawings.**

2.5 RESILIENT LATERAL GUIDES

A. These units shall incorporate elastomeric isolation elements which are specifically designed for providing resilient lateral bracing of vertically rising pipes.

B. Resilient lateral guides shall be one of the following products or approved equal:

1. Model ADA : by Mason
2. Model KPA : by Kinetics
3. Model AG : by V.M.C.

2.6 SEISMIC-RESTRAINT DEVICES <TEXT SHOULD BE REVIEWED AND EDITED BY PROJECT STRUCTURAL ENGINEER; ANY EDITS TO TEXT IN BLACK MUST BE REVIEWED BY THE PROJECT VIBRATION CONSULTANT;

<KEEP ONLY ONE OF A, B OR C>

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

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

C. Basis-of-Design Product: Subject to compliance with requirements, provide [**the product indicated on Drawings**] <**Insert manufacturer's name; product name or designation**> or an approved product by one of the following:

1. Amber/Booth Company, Inc.

2. California Dynamics Corporation.
3. Cooper B-Line, Inc.; a division of Cooper Industries.
4. Hilti, Inc.
5. Kinetics Noise Control.
6. Loos & Co.; Cableware Division.
7. Mason Industries.
8. TOLCO Incorporated; a brand of NIBCO INC.
9. Unistrut; Tyco International, Ltd.
10. <**Insert manufacturer's name**>.

D. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by **<Choose one>** [**an evaluation service member of ICC-ES**] [**OSHPD**] [**an agency acceptable to authorities having jurisdiction**].

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

E. Snubbers: Snubbers to limit the vertical and horizontal motion of the isolated equipment under seismic load shall be factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
3. Maximum 1/4-inch (6-mm) air gap, and a minimum 1/4-inch- (6-mm-) thick elastomeric pad shall be affixed at the point of contact.
4. There shall be no contact between snubbers and the inertia base or equipment support frame during normal operation. Snubbers must allow clear inspection of the non- contacting elements. The purpose of this requirement is to avoid short circuiting of the isolation system by the snubber system.
5. Snubber designs in compliance with the intent of this Section include:
   a. Mason Industries: Model Z-1225
   b. Kinetics Noise Control: Model HS-1, HS-2, or HS-5

F. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

G. Restraint Cables: **<Choose one or edit with another option>** [**ASTM A 603 galvanized**] [**ASTM A 492 stainless**]-steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement. Seismic restraint cables shall be of a

design, such as slack multi-strand aircraft cables, that can be installed and adjusted to function without interfering with the isolation systems.

H. Hanger Rod Stiffener: **<Choose one or edit with another option>** [**Steel tube or steel slotted-support-system sleeve with internally bolted connections**] [**Reinforcing steel angle clamped**] to hanger rod.

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

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

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

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

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

2.7 FACTORY FINISHES

A. Finish: Manufacturer's standard prime-coat finish ready for field painting.

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

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

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor shall obtain inspection from the Architect of any installation to be covered or enclosed prior to such closure.

B. The Contractor shall obtain written and/or oral instructions from the vibration isolation and seismic-control device manufacturer as to the proper installation and adjustment of such devices.

C. The Contractor shall correct, at no additional cost, all installations which are deemed defective in workmanship or materials by the Architect.

D. The Contractor shall be responsible for proper operation of all systems, sub-systems, and services provided under this Section. The Contractor shall coordinate startup procedures, calibration, and system check-out with all sub-contractors involved. Any system operational problems shall be diagnosed. All correctional procedures shall be initiated by the various contractors as required to bring the system into compliance with the design, and the problem shall then be rechecked to verify that the system operates normally. Any remaining difficulties shall be brought to the attention of the Architect.

3.2 EXAMINATION

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

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by [**an evaluation service member of ICC-ES**] [**OSHPD**] [**an agency acceptable to authorities having jurisdiction**].

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

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

3.4 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. The installation or use of vibration isolators or seismic-restraint device must not cause any change of position of equipment, conduit, or piping which would result in stresses in connections or misalignment of shafts or bearings. In order to meet this objective, equipment and attached systems shall be maintained in a rigid position during installation. Equipment

weight shall not be transferred to the isolator until the equipment installation is complete and under full operational load.

B. All plumbing and piping at mechanical equipment connections is to be fully supported by specified hangers. Plumbing and piping loads shall not be carried by plumbing equipment and its vibration mounts, unless otherwise required by this Specification.

C. Vibration isolators supporting equipment or piping shall be selected to have a stiffness at least ten times less than that of the building structural, or non-structural, components that support the isolators, or as directed by the vibration consultant. Vibration isolators must also

comply with the requirements of this Section and the required minimum static deflection indicated in this Section or **[in Table 22 05 48 – Vibration Isolation Schedule] [at the end of this section] [in the Mechanical Schedules].**

D. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

E. Equipment Isolator Installation:

1. Height-saving brackets shall be used for equipment supported on Type FSN vibration isolators.
2. The minimum operating clearance between the underside of the frame or inertia base and the pad or floor shall be 1 inch (25 mm).
3. The frame shall be placed in position and supported temporarily by shims prior to the installation of the machine or isolators.
4. After the entire system installation is completed and under full operational load, the isolators shall be adjusted so that the load is transferred from the shims to the isolators. When all isolators are properly adjusted, the shims will be barely free and shall be removed.
5. Except for the possible use of temporary snubbers during construction, seismic snubbers shall not receive final adjustment until vibration isolators are in-place and adjusted with actual operating loads.

F. Isolator Hangers

1. The isolators shall be installed with the isolator hanger box as close as possible to the structure but not in contact with the building structure.
2. The isolators shall be suspended from the stiffest portions or element of the structure above. In framed construction, this consists of beams and girders.
3. Orientation of isolator assembly including support and load rods shall be within five degrees of vertical.

G. Equipment Restraints:

1. Indicate type and quantity of snubbers described in first subparagraph below on Drawings or in the Plumbing Vibration-Control and Seismic-Restraint Device Schedule on Drawings.
2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
3. Install seismic-restraint devices using methods approved by **[an evaluation service member of ICC-ES]** **[OSHPD]** **[an agency acceptable to authorities having jurisdiction]** providing required submittals for component.

H. Piping Restraints:

1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of 40 feet (12 m) o.c., and longitudinal supports a maximum of 80 feet (24 m) o.c.

3. Brace a change of direction longer than 12 feet (3.7 m).

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

J. Install seismic-restraint devices using methods approved by **<Choose one> [an evaluation service member of ICC-ES]** [**OSHPD**] [**an agency acceptable to authorities having jurisdiction**] providing required submittals for component.

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

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

M. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

N. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre-stressed tendons, electrical and telecommunications conduit, and gas lines.

2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.

4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.

5. Set anchors to manufacturer's recommended torque, using a torque wrench.

6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.5 EQUIPMENT ISOLATION

A. Install isolators for fans, chillers, compressors, pumps and other such equipment as detailed in the **[Table 22 05 48 – Vibration Isolation Schedule] [at the end of this section] [in the Mechanical Schedules]** or as otherwise required. Unless otherwise specified in the Vibration Isolation Schedule or reviewed in advance by the Architect, no equipment of more than 3 horsepower (2 KW) shall be attached to the structure without suitable vibration isolation. Where piping or conduit connects to such equipment, provide flexible connectors as specified in Specifications or shown on the Drawings.

B. Mechanical equipment manufacturer shall approve complete vibration isolation system for all isolated equipment.

3.6 PIPING ISOLATION

A. Provide resilient wall and ceiling penetrations with sleeves for all piping, conduit, etc. Refer to resilient penetration details on Drawings.

B. Pipe support isolation shall comply with the following general guidelines:

1. Specified Extent of Isolation: Piping, 2 inches in diameter or greater, which is connected to vibration isolated equipment shall be isolated from the building structure (defined as any rigid building elements, such as normal structure; walls, whether load-bearing or not; and any other rigid components attached to the structure) using resilient supports, pipe guides, and penetration sleeves (as applicable) for a distance of 25 feet or 50 pipe diameters, whichever is greater.

2. Spring isolators shall be selected for a static deflection, under load, of not less than 1 inch (25 mm). Type FSN or HS isolators (whichever is applicable to the mounting condition) shall be used.

3. Where lateral support of pipe risers is required within the specified limits of isolation, this shall be accomplished by use of Type FSN, or resilient lateral supports with the specified minimum static deflection.

4. Pipes that penetrate the building structure within the specified extent of isolation shall be isolated from the structure by use of resilient penetration sleeves and seals.

5. Drain piping connected to vibration-isolated equipment shall not rigidly contact the building structure or other non-isolated system.

6. Piping connected to vibration-isolated equipment shall be installed so that it does not strain or force out of alignment pipe flexes or vibration isolators supporting either the equipment or the piping.

7. Where pipes are racked together, the most stringent isolation requirement, as defined in this Section shall take precedence.

8. Passive Mechanical Equipment: Passive mechanical equipment refers to equipment without motors such as cooling coils, heat exchangers, etc. For passive mechanical equipment connected to vibration-isolated mechanical equipment by piping of length less than 25 feet (8 m) or 50 pipe diameters, whichever is greater, with a diameter approved equal to or greater than 2 inches (50 mm):

   a. Provide vibration isolation flexible pipe connections at passive equipment.

   b. Support pipe connections between mechanical and passive equipment on hanger with the same type and deflection as the mechanical equipment support.

9. Unless otherwise required in this Section, gas, gravity drain, and fire protection piping are exempt from vibration isolation requirements.

3.7 EQUIPMENT BALANCE REQUIREMENTS

A. All rotating equipment shall operate at speeds less than 80 percent of their true critical speed. Unless otherwise required, equipment shall be balanced according to the recommendations given in the following sections. If balance requirements exist in other

Sections, the more stringent requirement shall apply.

B. Equipment components such as motors, pump rotors, etc. shall be factory balanced, both statically and dynamically, to meet the field balance requirements described below.

C. Balance Criteria: Pumps, compressors, and other rotating equipment shall be field tested in accordance with International Standard ISO 10816-1 and 10816-3 or ANSI Standard S2.41 (current edition) by an independent company after installation and under actual operating conditions. Vertical and horizontal vibration of rotating equipment shall not be greater than 0.07 inches/sec RMS (0.1 inches/sec 0-peak) [1.8 mm/sec RMS (2.5 mm/sec 0-peak)] velocity. The vibration shall be measured on the equipment bearing caps when the equipment is mounted on its vibration isolation mounts. A balance report will be provided for each item of equipment.

D. Inertia Base or Skid-Mounted Equipment Balance: The weight of inertia bases or skids (and of any other components mounted on the same inertia base or skid) will reduce the vibration

response when equipment is balanced. Therefore, the balance criteria shall be multiplied by the following factor for such equipment:

$$\text{Factor} = \frac{W}{WT+W}$$

Where

WT = Inertia weight (base + other components)

W = Weight of the subject equipment

3.8 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 22 Section "Hydronic Piping" for piping flexible connections.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**] [**Engage**] a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post-connection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.

4. Test at least [**four**] <**Insert number**> of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. Verify snubber minimum clearances.
9. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

D. Remove and replace malfunctioning units and retest as specified above.
E. Prepare test and inspection reports.

3.10 ADJUSTING

A. Adjust isolators after piping system is at operating weight.
B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
C. Adjust active height of spring isolators.
D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 22 05 48

SECTION 22 05 33 - ELECTRICAL HEAT TRACING

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section specifies materials and installation methods necessary for a thermostatically controlled electrical heat tracing system for grease waste piping, to maintain temperatures sufficient to keep fats oil and grease from congealing and to keep grease liquid and flowing to the grease interceptor.

1.2 RELATED WORK

A. Section 20 05 29 - Piping and Equipment Supporting Devices
B. Section 20 07 00 - Mechanical Systems Insulation
C. Section 26 05 33 - Raceway and Boxes for Electrical Systems
D. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
E. Section 26 08 00 - Commissioning of Electrical Systems
F. Section 26 09 00 – Electrical Instrumentation and Controls for Electrical Systems
G. Section 22 14 00 - Grease Waste and Vent System

1.3 SUBMITTALS

A. Pre-Construction Submittals: Manufacturer's technical data for each type of product.
   1. Heat Tracing Cables, indicating rated capacities, operating characteristics, product approvals.
   2. Thermostatic heating cable controller, with temperature recommended by and compatible with the manufacturer's heating cable, including temperature sensors, indicating rated capacities, operating characteristics, product approvals, and numbered circuit schedule, and amperage.
   3. Contractor certification from heat trace manufacturer.
   4. Sample of the Manufacturer's 10-year extended warranty statement.

B. Close-Out Submittals:
   1. Operation and Maintenance Data; Including Operation and Maintenance Manuals, Testing and Commissioning results recorded in the "Installation and Inspection Record" contained in Section 9 of the manufacturer's Installation and Operation manual, or other documentation as specified in the contract documents.
   2. Contractor shall supply as-built shop drawings as part of the closeout material package, including heat tracing layout, location of GW pipe temperature sensor(s), thermostatic control panels, and electrical power connection points, with schedule of numbered electrical circuits, with circuit length, breaker panel number, breaker number, and electrical load chart for circuits provided.
   3. Contractor certification from heat trace manufacturer.
   4. Written 10-year extended warranty statement.

1.4 SHIPPING

A. Package accessory kits in individual plastic bags to prevent loss of components. Subject heat cable to high-frequency spark test and braids to dry dielectric test as instructed by manufacturer.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Items shall be new, UL Listed or CSA or FM approved for their intended use.

2.2 TEMPERATURE MAINTENANCE HEAT TRACE

A. Manufacturers: nVent Thermal Management, Chromalox, Thermon or pre-approved approved equal

B. Heat Tracing:
   1. Self-Regulating heating cable shall consist of two 16 AWG tinned-copper bus wires imbedded in parallel in self-regulating polymer core, capable of varying its heat output along its entire length. Cable shall be covered by cross-linked polyolefin dielectric jacket, rated for 300 VAC at 221°F with VW-1 flame resistance and protected by tinned-copper braid continuous ground path, with an outer protective jacket of chemically resistant Fluoropolymer.
   2. Heating cable shall operate at 208 V, 240 V, or 277 V, single phase without use of transformers, and capable of maintaining system design temperatures up to 110º F (43º C) in project conditions.
   3. Heat cable cover shall be permanently marked with manufacturer's batch or serial number. Cable jackets shall be continuously marked with manufacturer's name, catalog number, nominal supply voltage and nominal power output in watts per foot in an approved equally permanent fashion. Use of temporary printing or tags is not allowed.
   4. Power retention of heating element shall be minimum of 90% after 72 h exposure in oven at 250°F while energized.
   5. Heat cable shall be capable of withstanding 1,600 VAC RMS (50 or 60 Hz) applied for 1 minute between parallel conductors and metallic braid.
   6. Heat tracing cable Basis of Design shall be Raychem XL-Trace, as manufactured in California by nVent Thermal Management.

C. Accessories:
   1. Include power connection kits, tee kits, end seal kits, splice kits, and thermostatic controllers supplied by same manufacturer as heating cable to protect the product warranty. Include fiberglass tape to fasten heat cable to pipe, heat reflective aluminized tape (as needed), and NEC “Electrically Traced” pipe markers, according to the manufacturer's instructions.
   2. Provide each Heat Tracing circuit with 30mA ground fault protection, incorporated either into the circuit breaker or as an integral part of the thermostatic controller.
   3. Protective electrical conduit, power wiring, junction boxes, and other electrical accessories shall be provided by Division 26 Contractor.
   4. Provide thermostatic heating cable controller with a temperature setpoint from 105°F to 110°F to keep fats oil and grease in GW piping liquid and flowing to the grease interceptor. Controller shall have the following features:
      a. Digital microprocessor-based heating cable controller with integral 30mA ground fault protection, with pipe temperature sensing, capable of monitoring and remote alarm for high & low temperature, low current or power failure, and ground fault, with both an isolated solid-state triac relay and dry contact relay, and with integral RS-485 communications BMS interface, automatically testing itself with a system check for proper operation. The controller shall be temperature adjustable and the

system capable of maintaining up to 110ºF system temperature, 100VAC to 277 VAC, single phase, with Nema 4X FRP enclosure. Basis of Design: nVent Raychem model C910-485 with RTD temperature sensor.

b. Temperature sensor shall be located on the GW piping, inside of the insulation, the sensor provided with a stainless-steel armored lead with threaded junction box connector, and connected to the controller, or can be extended with three-conductor 22 AWG low voltage shielded instrument cable inside of conduit for extended distance remote temperature sensing.

c. Connection kits shall be factory rated NEMA 4X, or connections shall be installed inside of Nema 4X junction boxes, to prevent water ingress and corrosion. All components shall be UV stabilized. Basis of Design Raychem FTC heat shrink or RayClic or FTC heat- shrink connection kits or pre-approved approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Insure safe handling of all heat tracing cable on the jobsite to prevent cuts breaks, kinks, or abrasions in compliance with the manufacturer's installation instructions.

B. Inspect and ensure that all pipe, fittings, and pipe support surfaces are clean and free of burrs and sharp edges that could damage the heating cable jacket.

C. Heating cable applied to underground piping systems shall be of one continuous length, and shall be protected inside of plastic conduit from piping to above ground power connections and terminations completed inside of project approved junction boxes. Cutting, splicing, tee's, or other damage to the heating cable underground will void the manufacturer's warranty.

D. Insulation for underground piping installations shall be pre-formed rigid Polyisocyanurate, Calcium Silicate, or FoamGlass, insulation designed for piping systems, provided with a waterproof wrap, or jacketed with PVC, as specified for underground applications, or as recommended by the insulation manufacturer.

E. Insulation for Above Ground heat traced piping systems shall be Fiberglass, or mineral wool, insulation designed for piping systems, and jacketed as specified for above ground applications, or as recommended by the manufacturer.

F. The installing contractor shall be responsible to ensure that the insulation size has been selected to allow for sufficient room to cover the pipe and the heating cable without efficiency rodding gaps or compression of the insulation material.

G. Install heat cable. The pipe temperature sensor shall be installed on the pipe, inside of the pipe insulation, and connective wiring shall be protected by electrical conduit up to project approved junction box.

H. Each Heat Tracing circuit shall be equipped with 30mA ground fault protection, either incorporated either into the circuit breaker provided by Electrical Contractor, or supplied as an integral part of the thermostatic controller.

3.2 INSPECTION

A. The heating cable system shall be inspected before the system is covered over with insulation to look for damaged heating cable and to ensure the manufacturer's recommended installation instructions have been observed.

3.3 TESTING

A. The General Contractor and/or the Construction Manager will coordinate with installing contractor and the Electrical contractor to ensure that the heat trace system is tested and energized for proper installed performance as per the manufacturer's Installation, Testing, and Commissioning instructions.

B. The heat tracing system should be subjected to an “insulation resistance test”, a “circuit length verification” test, a “power test”, and a “temperature test” as defined in the manufacturer's installation and testing instructions. Recording these test result readings for each circuit.

C. Contractor shall test continuity of both heater bus wires to verify connection of splices ortees.

D. Megger heater after thermal insulation has been installed and record readings. Insulation resistance should be at least 20 megohms when measured at 1000 V DC.

E. If the heating cable circuit fails either insulation resistance or continuity testing, the Electrician shall notify installing Contractor. The installing Contractor must repair or replace circuits yielding unacceptable readings. Megohmmeter testing must be witnessed and documentation of the test report shall be included with the Closing Submittal documents.

END OF SECTION 22 05 33

SECTION 22 05 94 - DOMESTIC WATER SYSTEMS BALANCE

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 22 11 18 – Water Distribution System

B. Section 22 21 14 – Plumbing Specialties

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. Plumbing Contractor shall be responsible for providing complete testing and balancing work of liquid fluid handling systems, such as domestic hot water return, laboratory hot water return, water mixing valves, and other processes included in this Project.

B. Work required shall consist of setting volume flow rates and adjusting speed controls, recording data, making tests, and preparing reports as specified herein.

C. Scope of work includes new work specified herein and includes all equipment, distribution systems, and terminal units connected.

D. Scope of work also includes CAL green required testing, adjusting and balancing of water heating systems.

E. Work is limited to new areas within construction boundaries and does not include central pumping equipment or other areas. Adjust and balance flows to values indicated or scheduled. If flow is abnormal, attempt to proportional balance flows to the same percentage below design and contact Owner's Representative for additional instruction.

F. Procedures shall be in accordance with the latest edition of AABC or NEBB and as per detailed herein.

G. TAB work shall be performed by persons trained in TAB work and certified by Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB). Contractors who are members of AABC or NEBB and who have qualified personnel available to perform work may submit Quality Assurance Submittal for approval.

H. Contractors who are members of AABC or NEBB and who have qualified personnel available to perform Work may submit Quality Assurance Submittal for approval. Contractors who cannot meet these requirements shall subcontract with independent TAB Contractor. TAB subcontractor shall prepare Quality Assurance Submittal for Contractor who will submit it for approval.

I. Owner will separately contract with an independent TAB Contractor to perform all testing, adjusting and balancing of HVAC hydronic systems required for this Project. Work related to testing, adjusting, and balancing that must be performed by Mechanical Contractor is specified in other sections of these Specifications.

J. Upon direction of Owner's Representative or TAB subcontractor, Contractor shall provide (at no additional cost to the Owner) any additional work and/or devices necessary to properly balance the system, including calibrated balancing valves, gauge tappings, flow sensors, and thermometer wells. Contractor shall be responsible for trimming and balancing pump impellers

as necessary to obtain design pump flow rates at minimum pressure differential.

K. TAB work shall not proceed until all assigned personnel have been approved by, Owner's Representative via Quality Assurance Submittal. Coordinate each phase of TAB work with overall project schedule. Each phase of TAB work shall be done in timely manner as detailed herein. Fieldwork must be complete before occupancy. Certificate of Substantial Completion shall not be issued until after Final Report is accepted by Owner's Representative.

1.4 SUBMITTALS

A. General:
1. Make submittals in accordance with Section 01 3300 – Submittals. Submit minimum of 5 copies of all submittals unless otherwise directed.
2. Reports shall be assembled using a 3-ring hard cover binder with Project Name and location on the cover and the side panel. Information sheets shall be 8-1/2" x 11" white bond paper. Use pre-printed forms of NEBB or AABC wherever possible. Assemble report in the following order.
   a. Transmittal letter
   b. Cover sheet with Project title, location, submittal date, and names and addresses of Owner, Contractor, TAB subcontractor, Architect, and Engineer
   c. Index of numbered tabs listing major systems
   d. Data organized by system in the following order:
      1) Equipment data and measurement summary
      2) Equipment measurement data
      3) Branch main measurement data
      4) Terminal device measurement data
   e. Provide numbered tabs for each system.

B. Quality Assurance Submittal:
1. Within 30 days of signing Contract, Contractor shall submit the following information:
   a. Firm resume
      1) AABC or NEBB active membership required
      2) Names of 3 recent relevant completed projects along with the project address, Owner's contact person, supervising design professional.
   b. Supervisor resume
   c. Balance technician(s) resume
2. Owner Representative and Owner reserve the right to contact previous project representatives and to reject persons whom Owner Representative and/or Owner feel are not qualified for this Project due to lack of relevant experience or problems on previous projects.

C. Planning Report:
1. Submit Planning Report as detailed in Part 3-EXECUTION of this Section to demonstrate to Owner Representative that proper procedures are being followed. Planning Report shall be submitted after Quality Assurance submittal and 30 days before fieldwork starts.

D. Initial Test Report:
1. Prior to starting Final Balance Phase, submit Initial Test Report as detailed in Part 3 of this Section to indicate to A/E and Contractor incomplete work or problem areas to be resolved before final balance is completed.

E. Final Report:
1. Within 30 days after fieldwork is completed, submit Final Report as detailed in Part 3 of

this Section to assure design objectives are met and to assist Owner in future maintenance.

1.5 REFERENCE STANDARDS

A. Refer to the latest publications of the NEBB, the American Society of Plumbing Engineers (ASPE) and the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) for establishing required procedures.

PART 2 - PRODUCTS

2.1 INSTRUMENTATION

A. Provide required instrumentation to obtain proper measurements. Application of instruments and accuracy of instruments and measurements shall be in accordance with requirements of NEBB or AABC Standards and instrument manufacturer's specifications.

B. Instruments used for measurements shall be accurate, and calibration histories for each instrument shall be available for examination by Owner Representative upon request. Calibration and maintenance of all instruments to be in accordance with requirements of NEBB or AABC Standards.

PART 3 - EXECUTION

3.1 GENERAL

A. TAB work shall be done in separate phases as outlined herein. Project schedule shall allow ample time to complete TAB work before occupancy. Follow procedures outlined herein and as described in Planning Phase narratives.

B. Set point for individual branch balancing valves in domestic hot water return, laboratory hot water return, tepid water systems shall be 0.5 gpm unless otherwise noted on drawings or schedules.

C. Set point for domestic hot water return and laboratory hot water return circulating pump shall be the flow rate defined in schedules on drawings.

3.2 PLANNING PHASE

A. Procedure:
   1. Obtain latest contract documents including addenda and change orders. Obtain shop drawings and performance curves from Contractor for pumps, flow measuring devices, and terminal devices. Prepare Planning Report as detailed herein. Make adjustments in Planning Report and/or measuring instrument calibration.

B. Planning Report:
   1. Planning Report shall contain the following minimum requirements.
      a. Narratives:
         1) Provide written narratives of procedures used. Provide separate narratives for each pump and liquid fluid handling system.
         2) Identify flow-measuring devices to be used at each pump and terminal device. Provide different narratives for constant and variable flow systems.

3) For non-standard water systems, include narratives on how to measure and adjust for different viscosities.
4) Narratives shall include references to published standards of NEBB or AABC. Narratives shall include measuring instruments to be used and ranges required for each procedure. Narratives shall include specified adjustment tolerances. For this Project, minimum acceptable is ± 10% of design flow.

b. Pre-balance Checklist: include, but not limited to:
1) Check for completeness or work
2) System cleaning
3) System fill and air venting
4) Place system into operation
5) Check expansion tanks and fill pressures
6) Pump bearings, alignment, starters, vibration isolators, rotation
7) Setting valves to proper position including shutoff and bypass valves
8) Set up of controls and control devices

c. Measuring Instrument List: list measuring instruments to be used for each procedure. Indicate ranges required for each procedure. Provide data on each measuring instrument to be used. This data shall include:
1) Manufacturer name and model number
2) Measurement range
3) Pressure/temperature limits
4) Date put into service
5) Date of last calibration
6) Include certificate from calibration firm

2. Owner's Representative reserves the right to request adjustments in any procedure and/or ask for recalibration of any measuring instrument, which has not been recalibrated within the past year.
3. Samples: Submit copies of TAB forms to be used.
4. Branch circuit and terminal measurements: indicate on pre-printed forms of AABC or NEBB measurements to be taken in the field. Include branch circuit or terminal identification, system, space served, location, design flows (include zone and system summaries), and flow measuring device size, type, Cv, and manufacturer. Indicate initial setpoint on forms.

3.3 SET-UP PHASE

A. Procedure:
1. Perform pre-balance checkout as per Planning Phase narrative.

B. Initial Test:
1. Measure pump data and flows in "as found" condition after initial valve settings are made.

C. Initial Test Report:
1. Submit report to Owner's Representative and Contractor indicating measurements made and make notes of items, which are not complete or are not within design tolerance.

3.4 FINAL BALANCE PHASE

A. Procedure:
1. Perform procedures as per Planning Phase narrative. Correct deficiencies and redo procedures as required before submitting Final Report.

B. Final Report:

1. Submit report to Owner's Representative and to Contractor indicating data and measurements as per requirements herein and per Planning Phase narrative. Do not submit partial or incomplete reports.

C. Final Report Adjustments:

1. Owner's Representative reserves the right to check any measurement made and to reject any portion of work not within the design tolerance of ± 10% of design flow. Contractor shall resubmit all or portions of Final Report as directed by Owner's Representative.

END OF SECTION 22 05 94

SECTION 22 10 05 – PLUMBING PIPING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Pipe, pipe fittings, specialties, and connections for piping systems.

1. Sanitary sewer.
2. Domestic water.
3. Flanges, unions, and couplings.
4. Pipe hangers and supports.
5. Manufactured sleeve-seal systems.
6. Valves.

1.02 REFERENCE STANDARDS

A. ASME B31.9 - Building Services Piping 2017.

B. NSF 61 - Drinking Water System Components - Health Effects 2017.

C. NSF 372 - Drinking Water System Components - Lead Content 2016.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Potable Water Supply Systems: Provide piping, pipe fittings, and solder and flux (if used), that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.

PART 3 EXECUTION

A. General Standards

1. All underground plumbing utility piping shall have a minimum of 12" sand encasement.
2. All underground plumbing utility piping shall have a minimum depth of 24” unless otherwise approved by the administrative authority after all existing utilities have been potholed by the contractor.

B. Design Documentation

1. Programming; For wet laboratories, studios, dark rooms, commercial kitchens, laundries, and other special use rooms requiring plumbing utilities to accommodate special functions, the Design Professional shall gather and document all information required to confirm Plumbing requirements as part of room programming. This information shall be included with the Design Development Submittal. Obtain and document the following information for each building room where special use plumbing services will be required.

- Room name
- Person requesting the plumbing services, Interviewer, Date
- Room use
- A list of required plumbing services. Include qualitative and quantitative data if available.
- Functions / processes which the required plumbing services are intended to accommodate. Provide sufficient information to ascertain the need for special plumbing provisions such as back flow prevention, pressure regulation, drain sediment traps, etc.
- A list of all equipment / apparatus which will require plumbing services. Include equipment manufacturer's data (connection size, use rate, etc.) if available.
- The above programming information may be omitted for rest rooms and residential kitchens where all required design data is covered by applicable codes.

C. Plumbing Calculations:

1. The Design Professional shall include final plumbing calculations with the 50% Working Drawing submittal. These calculations shall include the following:

   a. The room programming documents covered above.

   b. All assumptions clearly stated. In particular, document assumptions that had to be made in order to proceed with the design in the case of insufficient data being provided by the users. The intent here is to flag assumptions which the University should verify as correct.

   c. Applicable code requirements

   d. Tabulated design criteria for each plumbing service by system including:

      1) System

      2) Location of Service (Room number)

      3) Required flow quantity for each location including: water use fixture units, drainage fixture units, GPM flow rates for specialized equipment, natural gas load by both BTU/HR and CFH, CFH for air, vacuum and specialized gasses.

   e. Calculated data as required to select each piece of plumbing equipment including:

      1) Hot water heater demand and storage capacity.

      2) Sump pump sizing data,

      3) Lift station sizing data,

      4) Circulation pump sizing data.

f. Pipe sizing data including: combined flow for each pipe run, developed length for each pipe run, selected pipe size based on stated criteria (sizing chart, pressure drop, fluid velocity, etc. This data may be either in tabulated form or rough pipe schematic.

g. Rainwater leader calculations

D. Plumbing Working Drawings

1. General: Plumbing Working Drawings shall be sufficiently complete to assure high quality, fully functional plumbing systems, no contractual ambiguity, and also shall serve as a long-term record of the building's plumbing systems. The following guidelines apply to all Plumbing.

a. No work shall be called out in a manner which is not contractually enforceable. Plumbing quality level shall be fully identified to assure fair competitive bidding as well as a quality installation.

b. Design / build format for the plumbing section of the work as is sometimes used in residential plumbing construction shall not be used on Cal Poly projects. An exception to this guideline shall be the case of the entire building project being design / build format when approved by the University's Representative.

c. All points of connection to existing piping systems shall be identified. Verify points of connection by potholing where required.

d. All piping shall be sized.

e. The routing of ail piping shall be indicated. The indicated routing shall be verified to be feasible within the furring spaces indicated in the architectural drawings.

f. All equipment and fixtures shall be located. Maintenance access space as recommended by the manufacturer shall be indicated on the drawings.

g. All piping penetrations of the building shell shall be indicated.

h. Concrete core drills of existing structures shall be identified.

E. Provide a Plumbing Legend covering all symbols and abbreviations used in the plumbing drawings in order to have a fully enforceable contract.

F. Provide a Plumbing Schedule covering factory assembled plumbing equipment and fixtures. The intent should be the easy determination of the plumbing equipment included in the project to encourage competition among comparable product suppliers. Note that when a product manufacturer's name and model are called out on the schedule to serve as the basis of design, the specifications must be also be coordinated so that the same manufacturer is the first specified. See Division 1 Section of Cal Poly's standard for Product Options and Substitution Request procedures for further information.

G. Provide Plumbing Floor Plans to scale for each level where plumbing services are to be provided. Provide enlarged partial plans for congested areas such as public restrooms where

the normal scale plans will not adequately depict the work.

H. Sections to scale should be provided when the vertical arrangement of equipment and piping relative to other building components is critical for proper function or adequate maintenance clearance, as well as to assure the feasibility of pipe routing through tight spaces.

I. Plumbing Riser Diagrams: Plumbing riser diagrams shall be provided for multi-story buildings whenever the relative configuration of piping components cannot be depicted in the plan view alone without ambiguity. As a minimum, riser diagrams shall be provided in the Plumbing Working Drawings for the following systems: all drain waste & vent systems including lab waste, all hot water systems with circulation, all pure water systems, and any other system which includes forced circulation by pumping.

J. Plumbing Details: Plumbing details shall be provided as necessary to contractually assure a given level of quality. As a minimum, details shall be provided to cover all pipe penetrations of roofs, equipment supports, piping supports on roofs, backflow preventers, equipment installations where the relative position of plumbing appurtenances such as valves, unions, thermometer, drains, etc. are important to function, ease of service, and future replacement, pipe crossings of building expansion joints, pressure reducing assemblies, backflow prevention assemblies, roof drainage assemblies, floor drain assemblies, all pipe penetrations of exterior walls above and below grade.

K. Piping Diagrams (Schematics) shall be provided whenever the relative arrangements of plumbing components and equipment cannot be clearly depicted in the plans. As a minimum, piping diagrams shall be provided for in the Plumbing Working Drawings for water heating systems with circulation, pure water systems, and lift stations.

END OF SECTION 22 10 05

SECTION 22 11 00 – FACILITY WATER DISTRIBUTION

PART 1 GENERAL

1.01 SECTION INCLUDES DESIGN GUIDELINES

A. GENERAL INFORMATION

1. Cal Poly owns and maintains the underground water distribution system throughout the campus.

B. DESIGN REQUIREMENTS

1. All back-flow preventers will be tested by a certified tester prior to the system being put in service immediately after installation. .
2. Provide a domestic water pressure reducing valve and meter at each new building.
3. Provide a separate water meter and RP backflow preventer for irrigation at each new building.
4. Fire water should not be metered or reduced in pressure.
5. DCDA assemblies are required by Cal Poly and the County of San Luis Obispo.
6. For new buildings to be connected to the campus water system, the anticipated additional water demand should be identified early during preliminary planning. This water demand should be submitted to the Building Inspector and the Mechanical Engineer for Cal Poly Facilities Planning and Capital Projects.
7. Improvements to the campus system may be required to accommodate the additional demand. The Principal Engineer shall identify a suitable point of connection to the campus system and what system improvements may be necessary to accommodate the new building.

C. DESIGN CONDITIONS:

1. Water System Pressure: The water pressure assumed for system pipe sizing and design shall be the lower of the following:
   - ~~60~~ 75 PSI
   - The actual system pressure.
2. Since the water pressure in the campus water mains varies throughout the campus depending on elevation within four water pressure zones, the Plumbing Designer should request the water pressure from the University's Representative for each project. The University's Representative will provide the known pressure at a given point (usually a fire hydrant). The Plumbing Designer will be responsible for determining the pressure at the point of use and should take into account the change in elevation between the known reference point and the point of use.

END OF SECTION 22 11 00

Facility Water Distribution

22 11 00 - 1

SECTION 22 11 16 – DOMESTIC WATER PIPING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. ACCEPTABLE PIPING MATERIALS

1. Above Grade: Type L hard drawn copper tubing with wrought copper sweat fittings, 95/5 tin antimony solder for joining 2" and smaller pipe. 15% silver brazing conforming to AWS classification BCuP-5 for joining 2-1/2" and larger piping. Viega ProPress is acceptable up to 4" pipe.
2. Below Grade: Type K hard drawn or soft copper tubing, with wrought copper sweat fittings, all connections brazed with 15% silver brazing conforming to AWS classification BCuP-5, wrap pipe with 1 layer of 10 mil tape. Soft copper tubing with radius bends shall be used to minimize below grade fittings. (Note: Pipe layouts which place water piping under the building slab should be avoided whenever other alternatives are feasible.) Viega Pro Press is acceptable up to 4".
3. Below grade, beyond building footing, 3" and smaller piping, alternate material: Schedule 80 PVC pipe with socket fittings and solvent cement joints.
4. Below grade, beyond building footing, 4" and larger: Cement-mortar lined Class 150 ductile iron pipe with bell and spigot joints and cast-iron fittings. Specify restraining method: thrust blocks or restrained joints. Restrained joints should be called out for pipe configurations where thrust blocking will be difficult.
5. Below grade, beyond building footing, 4" and larger, alternate material: Class 200 AWWA C-900 PVC with bell and spigot joints and cast-iron fittings. Specify restraining method: thrust blocks or restrained joints. Restrained joints should be called out for pipe configurations where thrust blocking will be difficult.

B. WATER PRESSURE REDUCING VALVES

1. Provide a pressure reducing valve (PRV) which will limit the supply pressure to 80 PSI at the domestic water entry point to each building. This PRV shall be provided on water services with pressure below 80 PSI as well as above in order to provide additional protection in the event of a loss of pressure control in the campus water mains.
2. For low system pressures where a PRV may cause an undesirable pressure loss an exception to this requirement may be granted upon obtaining approval from the University's Representative.
3. Provide compound PRV's where required to accommodate a large range of flows.
4. Fire water should not be reduced in pressure. Separate fire water from domestic water ahead of the PRV.

C. VALVING

1. Water piping systems shall be provided with manual isolation valves at the following locations:
   a. At branch connections to underground system mains.
   b. At all building points of entry.
   c. On both sides of piped in devices which may need to be removed for servicing including water meters, back flow preventers, pressure reducing valves, strainers, pumps, etc. The devices shall be removable without draining down the building system.
   d. Exception: On small branch lines (1 inch and less) where the quantity of building water is small, the valve on the downstream side of the device may be omitted.
   e. At each floor where branch piping connects to a riser.
   f. At every restroom and every lab.

D. DOMESTIC / INDUSTRIAL HOT WATER

1. For water conservation, all systems shall be designed to provide near immediate hot water at fixtures by using either a hot water circulation pump or electric heat tape. An exception to this is small systems with a short distance (50 feet or less) between the water heater and the fixture. Verify with the University Representative whether heat tape or circulation will be used on a project by project basis.
2. For systems with a hot water circulation, verify that the pump is not over selected and that the pipe velocities due to circulation will be reasonably low. (Copper fitting failure due to high velocity scouring has been a problem). Grundfos Alpha Series Pumps are preferred.
3. Domestic hot water heaters shall be gas fired, to minimize campus electrical demand as well as energy use cost.
   a. Exceptions:
      1) Domestic hot water in buildings served by the campus central heating water system should be provided from a storage tank equipped with a double wall heat exchanger. (An exception to this may be allowed in the case of buildings with very low anticipated domestic hot water usage).
      2) Lavatories with small usage which are remotely located from a central system may be provided with hot water from a small electric storage type water heater with a maximum electrical demand of 1.5 kW. This exception shall not apply to shower usage. Instantaneous electric water heaters are not permitted due to high electrical demand.

4. Provide separate heating sources for domestic hot water and space heating water except for buildings served by the campus central heating water system.
5. Water heaters shall be installed in a sheet metal drain pan (smitty pan) with drain outlet piped to a safe location on the building exterior or floor drain.
   a. Exception: Water heaters installed on a concrete floor slab where leakage would not damage the floor or building. Provide a floor area drain in the vicinity of the water heater.
6. All hot water piping shall be insulated.
7. Water systems shall be designed to prevent water hammer. Provide properly sized shock arrestors adjacent to all quickly closing valves including toilet flush valves, washing machines, dish washers, and solenoid valves. Provide a ball valve below each shock arrestor to allow for removal without system drain down. Provide access doors for all shock arrestors in concealed locations. Shock arrestor locations and sizes should be positively identified within the contract documents.

E. DISINFECTION

1. All potable water systems shall be disinfected and analyzed for bacteriological content. No fire system shall be installed into the Campus Domestic loop without back flow prevention.
2. Bacteriological analysis shall be completed by a third-party laboratory approved by the Cal Poly Office of Environmental Health & Safety (EH&S). The laboratory shall be submitted via the University Representative for approval by EH&S a minimum of 72-hours prior to conducting disinfection. Analysis results shall be submitted via the University Representative to EH&S to certify compliance with the specifications. Disinfection procedure shall be repeated should EH&S indicate that compliance with the applicable regulations has not been achieved. Plumbing shop representative shall be given a copy of the results before the system can be put in service.
3. Provide an industrial water system for non-potable uses at all wet laboratories, faucets with serrated tip for hose connections, dark rooms, and all other locations using toxic or hazardous materials and requiring water service for uses other than drinking. Backflow protection shall be by a reduced pressure principal type back flow preventer.

END OF SECTION 22 11 16

SECTION 22 11 18 - WATER DISTRIBUTION SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section covers interior domestic cold water, domestic hot water, domestic hot water return, laboratory cold water, laboratory hot water, laboratory hot water return, tempered water, non-potable cold water and trap filler lines to a point 5 ft outside building wall.

B. All components shall comply with NSF-61 and NSF-372 to be compliant with requirement for lead content of ≤0.25% maximum weighted average.

1.2 RELATED WORK

A. Section 20 00 00 – General Mechanical Requirements

B. Section 20 05 13 - Motors

C. Section 20 05 14 - Variable Frequency Drive (VFD) Systems

D. Section 20 05 29 - Piping and Equipment Supporting Devices

E. Section 20 05 53 - Mechanical Systems Identification

F. Section 20 05 73 – Mechanical Systems Firestopping

G. Section 20 07 00 - Mechanical Systems Insulation

H. Section 22 05 94 - Domestic Water Systems Balance

I. Section 22 21 14 - Plumbing Specialties

J. Section 26 29 13 - Enclosed Controllers

1.3 QUALITY ASSURANCE

A. Order pipe with each length marked with manufacturer's name or trademark and type of pipe; with each shipping unit marked with purchase order number, metal or alloy designation, temper, size, and supplier's name.

B. Installed material not meeting specification requirements must be replaced with material that meets these Specifications without additional cost to Owner.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Promptly inspect shipments to ensure material is undamaged and complies with specifications.

B. Cover pipe to prevent corrosion or deterioration while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends from damage. End caps shall remain in place. Protect fittings, flanges, and unions by storage inside or by durable, waterproof, above ground packaging.

C. Offsite storage agreements will not relieve Contractor from using proper storage techniques.

D. Storage and protection methods must allow inspection to verify products.

E. Before shipping, piping shall be cleaned, free of rust and scale, and chemically treated to protect inside of pipe from rusting, and furnished with end caps.

1.5 SUBMITTALS

A. Manufacturer's technical data for the following:

1. Pipe

2. Fittings
3. Joints
4. Valves
5. Unions and Flanges
6. Dielectric fittings
7. Water hammer arrestors
8. Expansion joints
9. In-line Centrifugal Pumps
10. Pressure Booster Pump

B. Shop Drawings on items specified herein.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials as specified shall be new unless otherwise noted.

B. Materials shall be provided from list of approved manufacturers. Home Market, Generic Broker, or
Wholesaler's house brands are not acceptable.

2.2 PIPE, FITTINGS, AND JOINTS

A. Pipe, fittings, and joints for Water Main in Section 22 11 14 - Exterior Services to 5 ft from outside building wall.

B. Underground 3" and larger:
   1. Ductile iron:
      a. Pipe: Ductile iron, Class 52, AWWA C151, cement mortar lined with restrained mechanical joints and ductile iron fittings Verify if joints and fittings can be installed in direct buried water lines with the adopted Plumbing Code.
      b. Pre-insulated with polyurethane insulation and PVC jacket.

C. Underground 2-1/2" and Smaller:
   1. Copper:
      a. Pipe: Copper tube, Type K, soft (annealed) temper in coils, ASTM B88
      b. Fittings:
         1) Cast copper alloy, solder joint, pressure rated, ANSI B16.18
         2) Wrought copper, solder joint, pressure rated, ANSI b16.22
         3) Viega Pro Press
      c. Joints: Where joints are permitted, brazed, silver solder, BCuP-5 Type, AWS.A5.8, 1250°F melting point minimum.
      d. Pre-insulated with polyurethane insulation and PVC jacket.

D. Above Ground:
   1. Copper (2-1/2" and Smaller):
      a. Pipe: Copper tube, Type L, hard drawn, ASTM B88
      b. Fittings: Viega Pro Press
      c. Wrought copper, solder joint, pressure rated, ANSI B16.22

d. Joints:
   1) Lead free (<0.2%) solder, ASTM B32, flux, ASTM B813 d. Nipples: Red brass pipe, threaded
e. Viega ProPress is an acceptable fitting / material.
f. Exposed tubing and fittings in kitchen and areas subject to chemical cleaning shall have chrome plated finish.

2. Copper (2-1/2" and Larger):
   a. Pipe: Copper tube, Type L, hard drawn, ASTM B88
   b. Fittings:
      1) Wrought copper, solder joint, pressure rated, ANSI B16.22
   c. Joints: Brazed, BCuP-5 type, AWS A5.8, 1250°F minimum melting point
3. Viega ProPress is an acceptable fitting / material for up to 4".

2.3 UNIONS AND FLANGES

A. General:
   1. Unions, flanges and gasket materials to have pressure rating of not less than 150 psig at 180°F.
B. Copper (3" and Smaller):
   1. Wrought copper union, Nibco Figure 633-W. Mueller Brass or approved equal.
   2. Viega ProPress is acceptable.
C. Copper (4" and Larger):
   1. Cast red brass flanges, alloy 844, ASTM B584, Class 150, Standard bolt pattern, ANSI B16.24 with neoprene gasket.
   2. Viega ProPress is acceptable up to 4".

2.4 VALVES

A. Shutoff Valves:
   1. Ball Valves (2" and smaller):
      a. Acceptable manufacturers: Nibco, Apollo, Hammond, Milwaukee, Stockham and Watts with indicated features and approved equal to model listed. Note that not all manufacturers make all sizes. Jomar is an acceptable manufacturer for stainless steel and bronze.
      b. Full Port, 2 Piece: Lead Free, Stainless Steel or Bronze body, ASTM B584, stainless steel ball and stem, Teflon seats, stem extension with length according to installed system insulation thickness, 600 psi CWP pressure rating, Lockable, NIBCO T/S/PC-585-66-LF.
      c. Full Port, 3 Piece: Lead Free, Bronze body, ASTM B584, stainless steel ball and stem, Teflon seats, stem extension with length according to installed system insulation thickness, 600 psi CWP pressure rating, Lockable, NIBCO T/S-595-Y-66-LF.
      d. Insulated Handle: For insulated systems to prevent condensation on valve body with thermal and vapor seal, approved equal to NIBCO Nib Seal.
   2. Gate Valves:
      a. Acceptable Manufacturers: Nibco, Apollo, Crane, Hammond, Kennedy, Milwaukee and Stockham with indicated features and approved equal to model listed. Note that not all manufacturers make all sizes.
      b. Size 2-1/2" and Smaller: Lead-free bronze body, bronze trim, 300 psi CWP, union bonnet, rising stem, NIBCO T/S/PC-111-LF.
      c. Size 3" and Larger: Iron bodied with epoxy coating and resilient wedge. Mueller, NIBCO,

or approved equal.

B. Swing Check Valves:
   1. Size 2" and Smaller:
      a. Lead Free Bronze body, ASTM B584, Y pattern, PTFE resilient disc, horizontal swing, 200 psi CWP rating, Apollo 163S-LF series
   2. Valves 2-1/2" and Larger:
      a. Nickle iron body, horizontal swing, stainless steel or nickel iron disc, stainless steel replaceable seat, 200 psi CWP rating, NIBCO T/S/PC-413-Y-L.

C. Spring Check Valves:
   1. Valves 2" and Smaller:
      a. Lead Free Bronze body, ASTM B584, in-line lift type with spring, PTFE disc, 250 psi CWP rating, NIBCO T/S-480-Y-LF.
   2. Valves 2-1/2" and Larger:
      a. Cast iron body, wafer type, Buna-N seat, aluminum bronze disc, in-line type with stainless steel spring, 250 psi CWP rating, Nibco W-910-W-LF
      b. Ductile iron body, aluminum bronze or elastomer encapsulated ductile iron disc, stainless steel spring and shaft, welded-in nickel or EPDM synthetic rubber seat, vertical or horizontal installation, grooved ends, 300 psi CWP rating, Victaulic Series 716.

D. Balancing Valves:
   1. Circuit Setter:
      a. Acceptable Manufacturers: Bell and Gossett, Watts, Circuit Solver or approved equal
      b. 2" and Smaller: Shall be of lead-free bronze construction with glass and carbon-filled TFE seat rings and have differential pressure read-out ports across valve seat area. Read-out ports to be filled with internal EPT insert and better connection with check valve. Valve bodies to have 1/4" NPT tapped drain/purge port. Valves to have memory stop feature and calibrated nameplate to assure specific valve setting. Valve to be leak- tight at full-rated working pressure and temperature (300 psi/250°F), B&G Circuit Setter Model CB, or approved equal.
      c. Shall be regulated thermostatically

E. Mixing Valves
   1. Thermostatic Master Mixing Valve
      a. Acceptable manufacturers: Lawler, Watts Powers Intellestation or approved equal
      b. Master thermostatic mixing valve, capable of maintaining mixed water temperature within 5°F of setpoint at zero demand and peak flow with recirculated flow for temperature maintenance. Valve assembly shall be capable of sensing temperature in recirculated water temperature and returning water to main distribution if temperature is adequate or diverting partial flow to heater when temperature falls below setpoint.
      c. Mixing valve shall be bronze construction with dual thermostatic elements, integral thermometer, check valves, strainer, visual flow indicator and integral thermostatic return limiter. Valve shall be rated for 150 psig operating pressure and be certified under ASSE 1017.
      d. Valve shall have 140°F hot water inlet, 60°F cold water inlet and 120°F mixed water temperature. Power IntelliStation LFIS200TV or approved equal.
   2. Thermostatic Point of Use Tempered Water mixing Valve
      a. Acceptable manufacturers: Lawler, Powers or approved equal
      b. Master emergency fixture thermostatic mixing valve, capable of maintaining mixed water temperature within 5°F of setpoint. Valve shall fail to cold water supply only on loss of

hot water supply. Valve shall fail closed on loss of cold-water supply.

c. Mixing valve shall be bronze construction with dual thermostatic elements, high temperature limit stop, locked temperature regulator and integral thermometers on inlet, outlet and mixed water lines. Valve shall be rated for 125 psig operating pressure and be certified per ANSI Z358.1 requirements.

F. Classroom Laboratory Equipment Valves
   a. Basis of Design: T&S Brass
   b. Acceptable manufacturers: Chicago or approved equal.

2.5 WATER METERS

A. Compound Flow Meter
   1. Acceptable Manufacturers: Metron Farnier Spectrum or approved equal
   2. Meter shall be in-line compound meter type consisting of one positive displacement chamber and one turbine chamber. Meter shall have integral or remote converter with graphic display and keypad. Meter shall be factory sized and programmed for its specific application and flow range. Meter shall be reprogrammable using converter keypad without use of special interface device or computer.
   3. Meter body shall be lead-free bronze construction with stainless steel trim. Meter shall have thermoplastic piston, turbine chamber and turbine. Meter materials and finish shall meet AWWA Standard C700.
   4. Meter shall be provided with ANSI Class 150 flanges.
   5. Meter shall be selected for 10:1 turndown. Meter shall be wet-calibrated and accurate to within
      ±1.5% of reading. Meter shall be shipped with certification of calibration.
   6. Meter shall have 4-20 mA and programmable pulse output signals.
   7. [Meter shall have integral lead-free bronze or stainless-steel plate type strainer. Strainer shall have access cover for cleaning of strainer grid.
   8. Meter shall provide instantaneous and totalized flow in gpm and gallon.
   9. Basis of Design is Sensus Metering System. Refer to schedules on drawings.

2.6 DIELECTRIC FITTINGS

A. Insulating nipple, metal casing, inert thermoplastic lining, Clearflow dielectric fitting by Perfection Corporation or Victaulic Style 47.

B. Dielectric unions 2" and smaller; dielectric flanges 2-1/2" and larger; with iron female pipe thread to copper solder joint or brass female pipe thread end connections, non-asbestos gaskets and pressure rating of not less than 175 psig at 180°F. Watts Regulator Company, Lochinvar, Wilkins Epco Sales, Inc or approved equal.

C. Copper-silicon casting, UNS C87850, threaded or grooved end. UL classified in accordance with NSF-61 for potable water service. Victaulic Style 647.

2.7 WATER HAMMER ARRESTORS

A. Mechanical Water Hammer Arrestors:
   1. Piston-compressed air column type, with sealed air chamber.
   2. Manufacturers: Watts, Sioux-Chief, and Precision Plumbing Products (PPP), Inc., or approved equal to size shown. Provide access panels when mechanical shock stops are installed in non- accessible concealed locations.

2.8 EXPANSION JOINTS/LOOPS

A. Galvanized steel pipe, Schedule 40, with mechanical couplings, Victaulic 150 Mover
B. Copper Tubing:

1. Use expansion loops where space is available. Size expansion loops as listed in the following table:

Pipe Size	Length of Each Loop	Number of Legs
3/4″	38″	3
1″	40″	3
1-1/4″	42″	3
1-1/2″	46″	3
2″	50″	3
2-1/2″	54″	3
3″	60″	3
4″	68″	3

C. Copper Tubing:

1. Mechanical expansion fittings, size 3/4″ thru 4″, copper tube, stainless steel laminated internal bellows, 200 psi working pressure, 600°F rated; Keflex Model 7QT. Mechanical
2. expansion fittings, sizes 3/4″ thru 4″, copper tube, stainless steel laminated internal bellows, 175 psig working pressure, 500°F rated, Hyspan Model 8509 or 8510.
3. Allowable length of copper tube per mechanical expansion fitting shall be in accordance with the following table:

System Operating Temperature	Length of Pipe
110°F	300 ft
120°F	275 ft
130°F	250 ft
140°F	225 ft
150°F	175 ft
160°F	175 ft
170°F	150 ft
180°F	140 ft

D. Pre-manufactured expansion loop will be allowed: Metraflex Model MLS Series for sweat ends, MLT Series for threaded ends and MLF Series for flanged or groove ends. Verify pipe size required, laying length, and face-to-face dimension required. Coordinate location with other trades.

2.9 IN-LINE CENTRIFUGAL PUMPS FOR TEMPERATURE MAINTENANCE OF POTABLE AND LABORATORY HOT WATER

A. Manufacturers: Armstrong, Aurora, Bell and Gossett, Deming, Ingersoll-Rand, Taco, Weinman, Worthington or approved equal

B. Pumps shall be pipeline mounted, single suction type with cast iron casing, bronze fitted with working pressure of 125 psi and operating temperature of 200°F continuous.

C. Impellers shall be plastic and shall be directly hung from motor shafts without using flexible couplings.

D. Pump shafts shall be ceramic, steel or stainless steel, sealed and gasketed from pumped fluid.

E. Pumps shall be furnished with mechanical carbon/silicon carbide seals.

F. Bearing assemblies and motor shall be permanently oil lubricated and maintenance free.

G. Pump shall be controlled by adjustable programmable time clock similar to Bell and Gossett TC-1 timer kit and aqua stat located in return pipe at pump with 100°F to 240°F operating temperature with 5°F to 30°F adjustable differential, remote bulb, UL listed similar to Honeywell L6006A1012.

H. Refer to Section 26 29 13 - Enclosed Controllers.

2.10 PRESSURE BOOSTER PUMP

A. Manufacturers: Delta P Carver, Fluid Pump Systems, Grundfos, Quantum Flo, SyncroFlo or approved equal

B. Booster pump package shall have components frame mounted, piped, painted, wired and factory tested. Package shall include triplex pumps, hydro-pneumatic bladder tank and control panel. Pumps shall be configured to run in lead-lag-lag sequence. Package shall have single **[208] [240] [480]** V 3 Ph power connection with transformer provided for lower voltage requirement. Pump package shall be provided with auto-restart function on loss of power.

C. Pumps:
1. Pumps shall be horizontal close coupled end suction type.
2. Pumps shall have iron volute, backplate and bronze wearing rings; brass or bronze impeller, single suction enclosed type, keyed to shaft, hydraulically and dynamically balanced; stainless or carbon steel shaft with stainless steel or bronze sleeve; mechanical seals with carbon rotating against stationary ceramic seat.
3. Pumps shall be rated at 125 psig maximum working pressure and 225°F continuous temperature. Manufacturer shall certify ratings.
4. Pumps shall run without excessive noise or vibration.
5. Provide spare pump seals for each pump.

D. Each pump shall have open drip-proof high efficiency motor sized for non-overloading over entire pump curve.

E. Each pump and motor to have nameplate listing manufacturer's name, pump serial number, capacity in gpm and ft of head at design conditions, motor horsepower, voltage, frequency, speed and full load current.

F. Pump shall have manufacturer supplied VFD

G. Provide isolation valves at inlet and outlet of each pump. Valves shall be butterfly or ball valves as specified previously.

H. Pump manifold piping shall be Type L copper tube, hard drawn, ASTM B88.

I. Pumps shall have flexible suction and discharge braided pipe connectors, suction and discharge pressure gauges and common thermal relief valve. Discharge from relief valve shall be piped to 3" above floor at floor drain.

J. Package shall be controlled by skid mounted, UL listed NEMA 4 control panel with following components:
1. Magnetic starter for each motor with overload protection, external resets, and starter failure interlocks
2. Single door interlocked disconnect
3. H-O-A switch for each pump
4. Control circuit transformer with protected secondary
5. Time delays
6. Minimum run timers
7. Adjustable solid-state current sensing relays
8. Low suction pressure cutout
9. High suction pressure shutdown
10. Two sensor differential temperature no-flow shutdown
11. Pump operation and warning lights, and alarm horn

12. Automatic pump alternation of pumps 1, 2 and 3
13. Provide extra set of dry contacts in control panel for transmission of general fault alarm to building automation system.
14. Refer to Section 26 29 13 – Enclosed Controllers.

K. Hydro-pneumatic bladder tank shall be ASME rated with ring stand base and replaceable bladder. Tank shall include inlet and outlet pressure gauge, bladder charge pressure gauge and pressure switch for pump control.

L. Refer to schedule on Schedule for capacity requirements of pumps.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install pipe and fittings in accordance with reference standards, manufacturer's recommendations and recognized industry practices.

B. Maintain piping system in clean condition during installation. Remove dirt and debris from assembly of piping as work progresses. Cap open pipe ends where left unattended or subject to contamination.

C. Include connections to plumbing fixtures, to equipment by others, and to equipment requiring water. Provide proper backflow and back siphonage protection to safeguard potable water system from contamination.

D. Lay out water system so as to conform to intent of drawings. Coordinate piping with building features and work of other trades. Install water piping plumb and square with building. Plans indicate, general routing, provide additional offsets as required. Install piping with necessary swing joints and offsets to allow for expansion.

E. Install shut-off valves on branch lines near mains to avoid long dead-leg branches when valves are closed.

F. Install shut-off valves where indicated and at base of risers to allow isolation of portions of system for repair.

G. Do not install water piping within exterior walls.

H. Provide drain valves at base of risers and at low points of trapped piping 2” and larger where trapped water volume exceeds 5 gallons.

I. Install pressure reducing valves where indicated on drawings. Provide pressure gauges on both inlet and outlet sides of valve. Flush strainer and adjust to outlet pressure as scheduled.

J. Provide protective sleeve covering of elastomeric pipe insulation where copper or steel piping is embedded in masonry or concrete.

K. Provide dielectric fittings between dissimilar piping materials.

L. Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including required service space for this equipment, unless piping is serving this equipment.

M. Install valves and piping specialties, including items furnished by others, as specified and/or detailed. Provide access to valves and specialties for maintenance. Make connections to equipment, fixtures and systems installed by others where same requires piping services indicated in this

Section.

N. In-line pumps 3 hp and larger shall be independently supported from building structure.

O. Install water pipe using proper pipe and fittings. Use reducing fittings for changes in pipe size.

P. Install trap filler lines to slope to drain tailpiece without trapping.

3.2 UNDERGROUND WARNING TAPE

A. Provide warning tape for exterior buried utilities per Section 20 05 53.

3.3 COPPER TUBING

A. Copper tubing shall be installed per Copper Development Association guidelines in addition to methods specified herein.

B. Soldered Copper Joints:
1. Use non-acidic and lead-free flux on cleaned pipe and fittings for soldered joints.
2. Cut tube square, remove burrs from exterior of tube and ream interior of tube before assembly.
3. Fill joints with solder by capillary action. Solder shall cover joint periphery. Wipe joint clean.
4. Apply heat carefully to prevent damage to pipe, fittings and valves.
5. Follow manufacturer's recommendations when heating valves and equipment for soldered connections.

C. Brazed Copper Joints:
1. Cut tube square, remove burrs from exterior of tube and ream interior of tube before assembly.
2. Joints shall be cleaned and polished before brazing.
3. Flux of any type shall not be used.
4. Apply heat carefully to prevent damage to pipe, fittings and valves. Disassemble valves where possible to prevent damage to seats during brazing.

D. Pressed Fittings:
1. Viega ProPress is an acceptable fitting / material up to 4”
2. Cut tube square, remove burrs from exterior of tube and ream interior of tube before assembly.
3. Prepare joints properly before pressing.

3.4 SPRING LOADED CHECK VALVES

A. Provide spring loaded check valve in each pump discharge line.

3.5 WATER METERS

A. Provide minimum of 10 pipe diameters of straight pipe on inlet of meter and minimum of 5 pipe diameters of straight pipe on outlet of meter.

B. Provide strainer on inlet to meter.

3.6 WATER HAMMER ARRESTORS

A. Use water hammer arrestors to control water hammer. Installed devices shall be sized and located according to manufacturer's recommendations, PDI Standards, or as shown on drawings.

B. Use water hammer arrestors with flush valves and quick-closing valves. Provide access panels when water hammer arrestors are installed in non-accessible concealed locations.

3.7 DIELECTRIC UNIONS AND FLANGES

A. Install dielectric unions or flanges at points where copper-to-steel pipe connection is required in domestic water systems.

B. Install unions on equipment side of shutoff valves for items such as: water heaters, water softeners, pumps, filters, and similar equipment requiring periodic replacement.

3.8 EXPANSION JOINTS

A. Install one anchor on either side of expansion joint, opposite direction of expansion.

B. Install pipe guides on each side of mechanical expansion fittings.

3.9 CLEANING

A. Flush and clean piping prior to testing. Remove corrosion by mechanical or chemical means. Use chemicals that are non-toxic.

3.10 TESTING

A. Refer to Testing paragraph of Section 20 00 00 - General Mechanical Requirements.

B. Water test system may be applied to system in its entirety or in sections. Test piping with water to pressure of 100 psi for 2 h. No decrease in pressure allowed. Provide pressure gauge with shutoff and bleeder valve at highest point of system tested. Inspect joints in system under test.

C. Defective work or material shall be replaced or repaired as necessary and inspection and test repeated. Repairs shall be made with new materials. No caulking of threaded joints or holes will be allowed.

D. Do not conceal pipe until satisfactorily tested.

E. Testing with air will not be allowed.

3.11 BALANCING

A. Balance water distribution system. Adjust control valves for proper operation. Set balancing valves to maintain hot water in hot water system.

B. Balance flush valves, flow control valves and mixing valves for adequate flow and temperature to plumbing fixtures and equipment.

3.12 DISINFECTION

A. Disinfect water piping in the following manner:

1. Clean and flush water pipe with water until water at remote tap is clear.
2. Fill water systems with solution containing 50 ppm of chlorine (minimum concentration). Allow solution to stay in water system for 24 h. Alternately use solution of 200 ppm of chlorine (minimum concentration) for 3 h.
3. Flush water system of chlorine solution.
4. Allow clean water to stand in system for 24 h. Take sample from remote tap for bacteriological test.

B. Do not use water system for potable water supply until safe bacteriological test is obtained.Repeat steps 1 through 4 until safe water system is obtained.

3.13 BACTERIOLOGICAL TESTS

A. Take representative water samples and test to ensure bacteriologically safe water supply system.

Include HPC (Heterotrophic Plate Count) test and test for presence of Pseudomonas aeruginosa as well as regular coliform bacteria test. HPC test maximum containment level of 500 organisms/ml. Perform bacteriological tests shortly before Owner's acceptance of building. If tests fail, make corrections and retest.

B. When connecting to existing water supply of unknown quality, sample for analysis and comparison with finished water system analysis shall be taken prior to making new connection. This will allow isolating source of contamination from within scope of work or pre-existing water supply. Final conditions shall meet criteria specified above for areas within scope of work.

END OF SECTION 22 11 18

SECTION **221119** - DOMESTIC WATER PIPING SPECIALTIES PART

1 - GENERAL

PART 2 - PRODUCTS

2.1 BALANCING VALVES

A. Recirculating Domestic Hot Water Balancing Valves:

1. Balancing valves regulate and control the return of hot water to the water heater in a recirculating domestic hot water piping system to ensure that specified hot water temperatures are delivered to all point-of-use fixtures within specified time frames.
2. Manually Adjusted Balancing Valves: globe valve, needle valve, or venturi valve design with ports for reading temperature and pressure, knob adjustment with graduated set-point markings, and lockable memory setting. A ball valve design is not acceptable. A fixed GPM orifice flow regulation devices are not acceptable as they are not adjustable without disassembly and replacement of a different size orifice to change flow rate.
3. Automatically Self-adjusting Balancing Valves: mechanical thermostatically controlled valves that automatically self-adjust return water flow to maintain specified temperatures in the DHW circuits.
4. Electronic DHW balancing systems with remote temperature sensor(s) monitoring DHW circuit temperature(s) and controlling recirculating water flow with automated valves.
5. Material Construction: all metallic component parts shall be stainless steel or lead-free brass, lead free bronze, or copper. NPT threaded inlet and outlet for use with union connections. Balancing valve rated to 200 psi, 240°F (115°C).
6. Size: Same line size as their connected piping, but not larger than NPS 2".
7. Certified in compliance with NSF-61 Annex G, NSF-372 lead free.
8. Provide line size isolation valves and unions for ease of removal and service. Refer to piping detail shown on drawings. DHW balancing valves, their unions, isolation valves, and Y strainers (if used) shall be made accessible for service, and shall be identified with permanent metallic tags or signage.
9. Balanced System Testing, Adjustment, and Reporting: all recirculating domestic hot water circuits must provide specified hot water temperatures being delivered to point of use fixtures within specified time frames, and within specified acceptable variable tolerances, and in compliance with Commissioning Plumbing Section 220800.
    a. Manually Adjusted balancing valves must be individually tested and adjusted to balance DHW return flow rates to ensure specified water temperatures are being delivered to the fixtures. DHW balancing report shall include documented temperature readings and valve adjustment settings for each numbered DHW balancing valve, noting their numbered DHW circuits, DHW heater output temperature, test equipment used, testing and adjustment dates and the name of the testing mechanic.
    b. Automatically Self-adjusting systems can be checked by documented sampling of each recirculating circuits temperatures with a hand-held infrared sensor (IR sensor), or temperature readings taken at point-of-use fixtures within each DHW recirculating circuit. The DHW balancing report shall include documented sample temperature readings by numbered DHW circuits, noting balancing valves or the fixtures sampled by location, DHW heater output temperature, test equipment used, testing dates and the name of the testing mechanic.
10. Automatically Self-adjusting Thermostatic Valve Manufacturers: Subject to compliance with specified requirements, provide DHW balancing valves by one of the following:
    a. ThermoOmegaTech Inc, Circuit Solver #CSUAS series DHW lead-free thermostatic balancing valve
    b. Armstrong #DRV40 digital recirculation system
    c. Caleffi lead-free #116 Series Thermosetter balancing valve, provide Y strainer, and isolation valves

11. Manually Adjusted Valve Manufacturers: Subject to compliance with specified requirements, provide DHW balancing valves by one of the following:
    a. Red & White lead-free #9529AB DHW balancing valve, provide Y strainer, and isolation valves
    b. Griswold, K-Valve-No-Lead Series DHW balancing valves, provide Y strainer, and isolation valves
    c. Nibco Inc, #T-1710 series lead-free DHW balancing valves, provide Y strainer, and isolation valves.

SECTION 22 13 14 - SANITARY WASTE AND STORM DRAINAGE SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section includes materials and methods for sanitary waste and vent, clearwater waste and vent, storm drainage, and overflow storm drainage piping systems within and including piping to 5 ft outside building wall.

1.2 RELATED WORK

A. Section 20 05 13 - Motors
B. Section 20 05 20 - Excavation and Backfill
C. Section 20 05 29 - Piping and Equipment Supporting Devices
D. Section 20 05 49 - Seismic Anchorage and Restraints
E. Section 20 07 00 - Mechanical Systems Insulation
F. Section 22 11 14 - Exterior Services
G. Section 22 21 14 - Plumbing Specialties
H. Section 22 40 00 - Plumbing Fixtures

1.3 GENERAL DESIGN INFORMATION

A. Cal Poly owns and maintains the sanitary sewer system throughout the campus.
B. For new buildings to be connected to the sanitary sewer system, the anticipated additional sewer load should be identified early during preliminary planning. This load should be submitted to the Building Inspector and the Mechanical Engineer for Cal Poly Facilities Planning and Construction. Improvements to the campus system may be required to accommodate the additional load. The Principal Engineer shall identify a suitable point of connection to the campus system and what system improvements may be necessary to accommodate the new building.
C. Systems discharging to the campus sewer system shall be in compliance with the requirements of the City of San Luis Obispo Waste Water Treatment Plant. Mechanical systems discharging unusual wastes may require special provisions or may not be allowed. Triggers include; high or low pH, oil, grease, chemical contamination, biological contamination, and rain water to the sewer. Mechanical systems typically impacted include: commercial kitchen waste, elevator sump pump discharge, lab process waste, and water purification system waste. The Design Professional shall be responsible for confirming impacts to the project due to the City Waste Water Discharge Ordinance. Alternatives for compliance shall be discussed with the University's Representative. Negotiations involving specific project issues shall be channeled through the Cal Polly Office of Environmental Health & Safety (Director).
D. For wet laboratories, the method which will be used for dealing with contaminated liquid wastes should be determined early in the design process in consultation with the University's Representative and Cal Poly Environmental Health and Safety (EH&S). Contaminated liquid waste from laboratories are not allowed to be poured directly into drainage systems discharging to the campus sewers. EH&S should be consulted for procedures for dealing with liquid contaminated wastes. Contaminated wastes are typically containerized and held in the

laboratory for disposal by EH&S as hazardous waste. Lab waste piping systems are provided in wet laboratories only for disposal of non-hazardous liquids and as a precaution in case of an accidental spill.

E. Soil and Waste Piping within a building and outside within five feet (5') of the foundation, except where indicated otherwise, shall be No-Hub cast iron pipe and fittings, asphaltum coated, free from defects, and shall conform to the requirements of CISPI Standard 301 ASTM A-888 or ASTM A-74 and manufactured by AB & I, Charlotte or Tyler. Fittings shall be up with Stainless Steel, Heavy-Duty No-Hub Couplings and shall be in compliance with ASTM C-1540 and ASTM C-564 Standards, except all above ground vent piping joints may be made up with Standard-Duty No-Hub Coupling in compliance with CISPI -310, and ASTM C-564 Standards. For fats, oils and grease waste, Blucher Pipe systems are preferred.

F. Complete soil/waste drainage piping will be provided to each domestic plumbing fixture and will discharge by gravity. Sanitary drainage ventilation piping will be provided to each domestic plumbing fixture or trap and will terminate at various locations on the roof.

G. Horizontal sanitary, waste and vent piping will be designed for a uniform grade of 2% (1/4" per foot).

H. HVAC condensate drainage piping (CD) will be provided to each separate HVAC unit, such piping will drain to an indirect waste connection to the sanitary soil/waste system via either tailpiece connection at the nearest lavatory or sink or indirectly to a floor sink.

I. Floor drains will be provided in laundry rooms and all toilet rooms. Drains will not be located under the partitions and will be provided with clearance for service work.

J. Underground cast iron pipe will be wrapped with 8 mil polypropylene pipe wrap to protect against low pH soil on campus.

K. All floor drains will be served by a trap primer. The preferred trap primers will be flush-o-meter valve flushing tube or lavatory p-trap type. (Mechanical type trap primers may be provided only when the preferred type cannot be used.)h

L. Wall clean-outs at the end of runs for main lines should be provided, where possible, above rim height of highest fixture on that line of all floors.

M. Shower drains will be fitted with removable hair screens within floor drain for ease of maintenance.

N. Sink drains will be cleanable without disassembly of the associated trap, with cleanout above rim height of sinks on all floors.

O. Routing drainage piping overhead of electronic equipment, telecom equipment and electrical equipment will be avoided.

P. Cleanouts will be the same nominal size as the pipe they serve; where they occur in piping eight inches and larger, six inches size will be used. All cleanouts will be accessible.

Q. Cleanouts will be provided on all floors at the following locations:
   1. Horizontal offsets.
   2. End of soil, waste, water or storm drains more than five feet in length.
   3. Maximum of 50-foot intervals of horizontal runs within the building.
   4. Base of vertical sanitary stacks and storm drain leader lines.
   5. Each change of direction if the total aggregate change exceeds 90 degrees.

6. Main sewer connection outside of building. A 2-way cleanout with dual access plugs (threaded bronze, thermoplastic, or PVC) will be provided at this location. Cleanout will be installed in round cast iron valve box marked "Sewer".
7. Above rim height of all sinks and lavatories on all floors.
8. Above rim height of all urinals.
9. Up stream of all double santees and combinations.

1.4 ACCEPTABLE PIPING MATERIALS

A. Above Grade Sanitary Waste and Vent Piping: Service weight, no hub, cast iron soil pipe with cast iron DWV fittings, neoprene coupler with stainless steel clamp and shield.

B. Below Grade Sanitary Waste and Vent Piping: Service weight, no hub, cast iron soil pipe with cast iron DWV fittings, extra heavy neoprene coupler with stainless steel clamp and shield (Husky, Clamp All, or approved equal)

C. Above Grade Vent Piping (Alternate materials)
   1. Schedule 40 galvanized steel pipe with recessed screwed cast iron drainage fittings.
   2. Type DWV copper with DWV solder fittings, 50/50 equivalent lead-free solder.

D. Below grade DWV PVC and CPVC are acceptable above and below grade piping material.

E. Above / Below Grade Waste and Vent Piping (Alternate material for student housing buildings up to 3 stories only) Schedule 40 PVC,h DWV pipe and DWV fittings with solvent cement joints.

F. Waste vents shall be located a minimum distance of 30 feet horizontally from HVAC air intakes and occupied roof areas. Additionally, waste vents shall be extended with a support system to a level seven feet above the roof when the roof is occupied (such as in the case of roof mounted greenhouses). Waste vents shall not be located in confined roof wells where HVAC air intakes are located.

G. Provide accessible cleanouts at all levels of the building the same as required by code for first floor and lower levels.

H. Avoid sewage lift stations where possible. Gravity flow of sewage is preferred and is usually achievable due to the significant elevation change of most building sites on the campus. If a lift station is required, minimize the required capacity by segregating out upper level waste which can be gravity flow. Lift stations should be duplex pump type, powered by emergency power, with alarm contacts provided as an input to the building management system. Lift stations which handle rest rooms sewage shall be grinder type. Provide pumps with rail system option.

I. Floor drains shall be equipped with trap primers. Trap primer shall be accessible and equipped with a shut off valve to allow for servicing without system drain down.

1.5 QUALITY ASSURANCE

A. Order piping with each length marked with manufacturer's name or trademark and type of pipe; with each shipping unit marked with purchase order number, metal or alloy designation, temper, size, and supplier's name.

B. Installed material not meeting specification requirements must be replaced with material that meets these specifications without additional cost to Owner.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Promptly inspect shipments to insure material is undamaged and complies with Specifications.

B. Cover pipe to prevent corrosion or deterioration while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends from damage. End caps shall remain in place. Protect fittings by storage inside or by durable, waterproof, above ground packaging.

C. Offsite storage agreements will not relieve Contractor from using proper storage techniques.

D. Storage and protection methods must allow inspection to verify products.

1.7 SUBMITTALS

A. Manufacturer's technical data for the following:

1. Pipe and fittings
2. Joints
3. Cleanouts
4. Floor drains and floor sinks
5. Roof drains
6. Downspout boots
7. Downspout nozzles
8. Air gap fittings
9. Backwater valves
10. Discharge check valves
11. Discharge isolation valves
12. Trench drains
13. Traps
14. Sump pumps
15. Sewage ejectors
16. Concrete sump basins
17. Epoxy coating of concrete sump
18. Sump cover Oil

PART 2 - GENERAL

2.1 MATERIALS

A. Materials herein specified shall be new, unless otherwise noted.

2.2 ACCEPTABLE PIPING MATERIALS

A. Above Grade Sanitary Waste and Vent Piping: Service weight, no hub, cast iron soil pipe with

cast iron DWV fittings, neoprene coupler with stainless steel clamp and shield.

B. Below Grade Sanitary Waste and Vent Piping: Service weight, no hub, cast iron soil pipe with cast iron DWV fittings, extra heavy neoprene coupler with stainless steel clamp and shield (Husky, Clamp All, or approved equal)

C. Above Grade Vent Piping (Alternate materials)
   1. No hub cast iron
   2. Type DWV copper with DWV solder fittings, 50/50 equivalent lead-free solder.

D. Below grade DWV PVC and CPVC are acceptable above and below grade piping material.

E. Above / Below Grade Waste and Vent Piping (Alternate material for student housing buildings up to 3 stories only) Schedule 40 PVC,h DWV pipe and DWV fittings with solvent cement joints.

F. Waste vents shall be located a minimum distance of 30 feet horizontally from HVAC air intakes and occupied roof areas. Additionally, waste vents shall be extended with a support system to a level seven feet above the roof when the roof is occupied (such as in the case of roof mounted greenhouses). Waste vents shall not be located in confined roof wells where HVAC air intakes are located.

G. Provide accessible cleanouts at all levels of the building the same as required by code for first floor and lower levels.

H. Avoid sewage lift stations where possible. Gravity flow of sewage is preferred and is usually achievable due to the significant elevation change of most building sites on the campus. If a lift station is required, minimize the required capacity by segregating out upper level waste which can be gravity flow. Lift stations should be duplex pump type, powered by emergency power, with alarm contacts provided as an input to the building management system. Lift stations which handle rest rooms sewage shall be grinder type.

I. Floor drains shall be equipped with trap primers. Trap primer shall be accessible and equipped with a shut off valve to allow for servicing without system drain down.

2.3 PIPE, FITTINGS, AND JOINTS

A. Interior Underground 15" and Smaller:
   1. Schedule 40 polyvinyl chloride pipe (PVC), ASTM D1784, with solvent cement joints:
      a. Manufacturers: Charlotte, Spears or approved equal
      b. No hub cast iron

B. Interior Above Ground:
   1. Schedule 40 chlorinated polyvinyl chloride lab waste pipe (CPVC), ASTM D1784, with solvent cement joints.
      a. Provide 3M™ Fire Barrier Plenum Wrap 5A+ for piping above ceiling areas unless the piping material is rated to comply with ASTM E84 / UL 723 to have a flame spread of less than 25 and smoke developed index of less than 50 for use in plenum ceilings.
      b. Manufacturers: Charlotte, Spears or approved equal
      c. No hub cast iron

2.4 CLEANOUTS

A. Josam, Mifab, Smith, Wade, Watts or Zurn, approved equal to number shown on or indicated by drawings.

B. Provide recessed, solid brass, cleanout plugs where fittings are used as cleanouts. Provide taper-thread plug with Teflon tape thread wrap.

C. Floor Cleanouts: Cleanout with cast iron ferrule, adjustable top, nickel-bronze scoriated cover and frame, bronze taper-thread plug, approved equal to J.R. Smith 4033L. Provide flashing flange and clamp where cleanout is installed in elevated slabs, approved equal to J.R. Smith 4033L-F-C.

D. Floor Cleanouts, Unfinished Floors and Areas Outside Building: Cleanout with cast iron ferrule, adjustable round top, scoriated cast iron tractor cover, and bronze taper-thread plug, approved equal to
J.R. Smith 4239L. Provide flashing flange and clamp where cleanout is installed in elevated slabs, approved equal to J.R. Smith 4239L-F-C.

E. Floor Cleanouts, Areas with Heavy Traffic: Cleanout with cast iron ferrule, adjustable housing, heavy-duty ductile iron scoriated top, and brass taper-thread plug, approved equal to J.R. Smith 4233L-
M. Provide flashing flange and clamp where cleanout is installed in elevated slabs, approved equal to J.R. Smith 4233L-M-F-C

F. Wall Cleanouts: Cleanout with cast iron counter sunk ferrule, bronze or brass taper-thread plug, secured stainless steel access cover, approved equal to J.R. Smith 4472T. Wall clean outs to be plumbed 2" or less from face of wall.

2.5 FLOOR DRAINS

A. JR Smith, Blucher, Mifab, Smith, Wade, Watts or Zurn, approved equal to number as shown on drawings.

B. Floor drains shall be in accordance with ANSI A112.21.1. Provide with caulked or no-hub connection. Floor drains shall have internal seepage collar for embedding in floor construction and weep holes to provide adequate drainage to drain pipe. Include trap primer connection where indicated on drawings.

C. Refer to schedule.

2.6 FLOOR SINKS

A. JR Smith, Mifab, Smith, Wade, Watts or Zurn, approved equal to number as shown on drawings.

B. Floor sink shall be in accordance with ANSI A112.21.1. Provide with caulked or no-hub connection. Double drainage pattern floor sink shall have anchoring and seepage flanged for embedding in floor construction and weep holes to provide adequate drainage to drain pipe. Include trap primer connection where indicated on drawings.

C. Refer to schedule

2.7 ROOF DRAINS AND OVERFLOW DRAINS

A. JR Smith, Mifab, Smith, Wade, Watts or Zurn, approved equal to number as shown on drawings

B. Roof drains and overflow drains shall have cast iron body with adjustable collar, cast iron flashing ring, gravel stops, 10” diameter cast iron dome strainer, and cast-iron underdeck clamp. J.R. Smith 1010Y-RC-CID.

C. Expansion joints shall be cast iron joint with bronze pipe sleeve and neoprene gasket. J.R. Smith 1710.

2.8 AIR GAP FITTINGS

A. Air gap fittings constructed of cast iron with integral air gap having free area of at least twice

the inlet area. Josam, Mifab, Smith, Wade, Watts or Zurn, approved equal to J.R. Smith 3950 or 3951.

2.9 DOWNSPOUT NOZZLES

A. Acceptable Manufacturers: Josam, Smith, Wade or Zurn approved equal to number listed

B. Downspout nozzles shall be polished bronze body, wall flange and threaded inlet, approved equal to J.R. Smith #1770-PB.

2.10 TRAPS

A. Same material as pipe or fittings unless specified with fixtures. Refer to Section 22 4000 - Plumbing Fixtures. Provide 17 ga brass, chrome plated traps for exposed traps.

2.11 COOLING COIL CONDENSATE DRAIN/CLEARWATER WASTE

A. Piping shall be one of the following, unless otherwise indicated on drawings:
   1. Galvanized Steel
      a. Pipe: ASTM A53, Grade A or B, Type F, standard weight, galvanized steel
      b. Fittings: ASTM A126/ASME B16.4, cast iron, threaded, ASTM A123 galvanize coated
   2. Copper
      a. Pipe: ASTM B88, Type L, hard temper copper tubing
      b. Fittings: ASTM B16.22 wrought copper fittings
      c. Joint: ASTM B32, 95-5 tin-antimony solder, Bridgit or Silvabrite, Viega Pro Press

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

A. Install pipe and fittings in accordance with reference standards, manufacturer's recommendations and recognized industry practices.

B. Connect piping to fixtures, each piece of equipment, and drains. Install required piping as shown on drawings.

C. Grade horizontal lines with minimum of 1/8" per ft, except piping 2" diameter or smaller which shall be run at 1/4" per ft slope.

D. Grade horizontal lines with minimum of 1/4" per ft, except piping 4" diameter or larger which may be run at 1/8" per ft slope with approval of local authority.

E. Install piping parallel with building lines and at heights, which do not obstruct any portion of window, doorway, stairway, or passageway, except, as may be shown on plans. Install overhead piping as high as possible.

F. Grade vent pipe for complete drainage by gravity to soil or waste pipes. Vent terminations shall be set true and level. Locate vent piping at least 10 ft away from window, door or intake openings. Coordinate closely with roofing contractor to prevent damage to roofing membrane. Flashing shall be in accordance with requirements of roofing manufacturer.

G. Where interferences develop, offset or reroute piping as required to clear interferences. Coordinate locations of plumbing piping with piping, ductwork, conduit and equipment of other trades to allow sufficient clearances. Consult drawings for exact location of pipe spaces, ceiling heights, door and window openings, or other architectural details before installing piping.

H. Provide protective sleeve covering of elastomeric pipe insulation, where piping and/or fittings are embedded in masonry or concrete.

I. Maintain piping in clean condition internally during construction.

J. Mitered ells, notched tees, and orange-peel reducers are not allowed. Bushings are not allowed on threaded piping.

K. Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including required service space for this equipment, unless piping is serving this equipment.

L. Set cleanouts true and level and protect properly throughout construction.

M. Set floor drains true and level and protect properly throughout construction. Weep holes shall be filled with removable material and kept free from concrete and other debris during construction. Weep holes shall be cleaned out for final working order. Provide safing for floor drains installed in elevated slabs.

N. Trap each fixture and piece of equipment requiring sanitary drainage connections. Trap seals shall be standard depth, except when deep seals are required by code. Traps shall be set true and level and located within limits of code requirements. Traps shall not be used as separator, interceptor or other type of device to retain solids. Traps shall be provided with thread type approved cleanout plugs when specified. Protect traps during construction and seal off to prevent stones, debris and other foreign matter from entering before use. Locate running traps for full accessibility with double cleanout.

O. Provide plugs or caps for pipe openings during construction to prevent debris from entering pipe. Temporary plug shall be plastic cap or equivalent.

3.2 UNDERGROUND WARNING TAPE

A. Provide warning tape for exterior buried sewers per Section 20 0553.

3.3 COPPER TUBING

A. Copper tubing shall be installed per Copper Development Association guidelines in addition to methods specified herein.

B. Soldered Copper Joints:
   1. Use non-acidic and lead-free flux on cleaned pipe and fittings for soldered joints.
   2. Cut tube square, remove burrs from exterior of tube and ream interior of tube before assembly.
   3. Fill joints with solder by capillary action. Solder shall cover joint periphery. Wipe joint clean.
   4. Apply heat carefully to prevent damage to pipe, fittings and valves.
   5. Follow manufacturer's recommendations when heating valves and equipment for soldered connections.
   6. Viega Pro Press or approved equal to be installed to manufacture recommended installation instruction

3.4 STEEL PIPE

A. Threaded Pipe Joints:
   1. Make threaded pipe joints with square cut and reamed pipe. Provide tapered pipe threads in conformance with ANSI B1.20.1.

2. Cut threads so that exposed threads at joint are less than 3. Coat exposed threads with corrosion inhibiting paint. Use joint compounds or Teflon tape on pipe threads to achieve leak free joint.

3.5 CAST IRON PIPE

A. No-hub Piping: Place gasket on end of one pipe of fitting and clamp assembly on end of other pipe or fitting. Firmly seat pipe or fittings ends against integrally molded shoulder inside neoprene gasket. Slide clamp assembly into position over gasket. Tighten fasteners to manufacturer's recommended torque.

B. Install cast iron pipe and fittings as recommended by CISPI in their publication "Installation of Cast Iron Soil Pipe and Fittings".

C. Support piping at every coupling. Locate hanger within 18″ of coupling.

D. Installations with multiple joints within a 4 ft developed length shall be supported at every second joint.

E. Secure base of risers with thrust restraints to prevent joint separation. Restraint shall be in accordance with CISPI recommendations.

F. Brace horizontal piping 5″ and larger to prevent horizontal movement. Install bracing at every branch connection and every change of direction in accordance with CISPI recommendations.

3.6 TESTING

A. Refer to Testing paragraph of Section 20 0000 - General Mechanical Requirements.

B. Water test may be applied to system either in its entirety or in sections. Piping shall be tightly plugged and submitted to 10 ft head of water located at highest point. Provide separate standpipe above highest point being tested or extend system to obtain required 10 ft head of water. Head shall be maintained for at least 30 minutes before inspection starts.

C. Defective work or material shall be replaced or repaired as necessary and inspection and test repeated. Repairs shall be made with new materials. No caulking of threaded joints or holes will be allowed.

D. Do not backfill pipe until successfully tested.

E. Testing with air will not be allowed.

3.7 COOLING COIL CONDENSATE DRAIN/CLEARWATER WASTE

A. Trap each cooling coil drain pan connection with trap seal of sufficient depth to prevent conditioned air from moving through piping. Extend drain piping to nearest code approved drain location. Construct trap with plugged tee for cleanout purposes.

B. Pitch pipe down at 1/4" per one foot for proper drainage.

C. Where copper piping is allowed, joints and fittings may be secured with 95-5 tin-antimony solder or brazing alloys.

END OF SECTION 22 13 14

SECTION 22 14 00 - GREASE WASTE AND VENT SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section includes materials and methods for grease waste and vent piping within building and including piping to grease interceptor outside building.

1.2 RELATED WORK

A. Section 20 05 20 - Excavation and Backfill
B. Section 20 05 29 - Piping and Equipment Supporting Devices
C. Section 20 05 49 - Seismic Anchorage and Restraints
D. Section 20 05 53 - Mechanical Systems Identification
E. Section 20 05 73 - Mechanical Systems Firestopping
F. Section 20 07 00 - Mechanical Systems Insulation
G. Section 22 11 14 - Exterior Services
H. Section 22 21 14 - Plumbing Specialties
I. Section 22 40 00 - Plumbing Fixtures
J. Section 22 05 33 - Electrical Heat Tracing

1.3 QUALITY ASSURANCE

A. Order piping with each length marked with manufacturer's name or trademark and type of pipe; with each shipping unit marked with purchase order number, metal or alloy designation, temper, size, and supplier's name.
B. Installed material not meeting specification requirements must be replaced with material that meets these specifications without additional cost to Owner.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Promptly inspect shipments to ensure material is undamaged and complies with Specifications.
B. Cover pipe to prevent corrosion or deterioration while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends from damage. End caps shall remain in place. Protect fittings by storage inside or by durable, waterproof, above ground packaging.
C. Offsite storage agreements will not relieve Contractor from using proper storage techniques.
D. Storage and protection methods must allow inspection to verify products.

1.5 SUBMITTALS

A. Manufacturer's technical data for the following:
   1. Pipe and fittings
   2. Joints
   3. Cleanouts
   4. Floor drains
   5. Traps
   6. Grease Traps
   7. Grease Interceptor
   8. Precast Grease Interceptor

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials herein specified shall be new, unless otherwise noted.

2.2 PIPE, FITTINGS, AND JOINTS

A. Interior Underground 10" and Smaller:
   1. CPVC under 140 degrees F. and Blucher stainless steel piping above 140 degrees F. are the preferred piping materials.
   2. Cast Iron:
      a. Pipe: Hubless cast iron pipe, ASTM A-888, CISPI 301, NSF certified with material test reports marked with collective trademark of Cast Iron Soil Pipe Institute
      b. Fittings: Hubless cast iron fittings, ASTM A-888, CISPI 301, NSF certified with material test reports from 3 dates selected by Owner's Representative marked with collective trademark of Cast Iron Soil Pipe Institute
      c. Joints: Heavyweight no-hub couplings with stainless steel clamps, FM 1680 Class 1, ASTM C-1540, Mission Heavyweight, Husky Series 4000, Ideal Tridon "HD", or Clamp-All Hi-Torq

B. Interior Above Ground:
   1. CPVC under 140 degrees F. and Blucher stainless steel pipe above 140 degrees F. are the preferred piping materials.
   2. Cast Iron:
      a. Pipe: Hubless cast iron pipe, ASTM A-888, CISPI 301, NSF certified with material test reports from marked with collective trademark of Cast Iron Soil Pipe
      b. Fittings: Hubless cast iron fittings, ASTM A-888, CISPI 301, NSF certified with material test reports from marked with collective trademark of Cast Iron Soil Pipe Institute
      c. Joints: Heavyweight no-hub couplings with stainless steel clamps, FM 1680 Class 1, ASTM C-1540, Mission Heavyweight, Husky Series 4000, Ideal Tridon "HD", or Clamp-All Hi-Torq 125

C. Adapter Couplings for Joining Dissimilar Pipe Materials:
   1. Acceptable Manufacturers: Fernco, Mission or approved equal
   2. 1" through 6" diameter: Fernco Proflex 3000 Series shielded coupling with neoprene gasket, stainless steel shield, and stainless-steel clamping bands. Adapter couplings shall be specifically designed for pipe materials being joined.

2.3 CLEANOUTS

A. Josam, Smith, or Zurn, approved equal to number listed in Drains and Cleanout Schedule.

B. Cleanout material shall be similar to pipe material.

2.4 FLOOR DRAINS

A. Blucher, Josam, Smith, or Zurn, approved equal to number as shown on drawings.

B. Floor drains shall be in accordance with ANSI A112.21.1. Floor drains shall have internal seepage collar for embedding in floor construction and weep holes to provide adequate drainage to drain pipe. Include trap primer connection where indicated on drawings.

2.5 TRAPS

A. Same material as pipe or fittings unless specified with fixtures. Refer to Section 22 4000 - Plumbing Fixtures. Provide 17 ga brass, chrome plated traps for exposed traps.

2.6 GREASE INTERCEPTOR

A. Acceptable Manufacturers: Schier or approved equal.

B. PDI certified, high strength, polyethylene construction to ASTM specification, designed to remove grease and solids from effluent until accumulations can be removed by pumping the interceptor.

C. Interior walls finished smooth and impervious. Voids, pits or protrusions exterior and interior are prohibited.

D. Interceptor shall have two compartments of approved equal volume for a total design holding capacity measured in gallons. Each compartment shall be provided with internal baffling, inlet / outlet cleanout, 4" inlet connection, 4" outlet connection, 6" vent ports and sample ports.

E. Access to each tank shall be via two 24" diameter frame and H-20 covers connected to tank extension collars. Cast-iron covers shall have the words INTERCEPTOR cast into it.

F. Grease interceptor shall be installed in compliance with the manufacturer's recommendations.

G. Refer to Grease Interceptor schedule on drawings for sizing and further information.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

A. Install pipe and fittings in accordance with reference standards, manufacturer's recommendations and recognized industry practices.

B. Avoid cleanout plugs in ceiling cavities. Where cleanouts are required, extend pipe to floor cleanouts in slab above.

C. Connect piping to fixtures, each piece of equipment, and drains. Install required piping as shown on drawings.

D. Grade horizontal lines with minimum of 1/8" per ft, except piping 2" diameter or smaller which shall be run at 1/4" per ft slope.

E. Grade horizontal lines with minimum of 1/4" per ft, except piping 4" diameter or larger which may be run at 1/8" per ft slope with approval of local authority.

F. Install piping parallel with building lines and at heights, which do not obstruct any portion of window, doorway, stairway, or passageway, except, as may be shown on plans. Install overhead piping as high as possible.

G. Grade vent pipe for complete drainage by gravity to soil or waste pipes. Vent terminations shall be set true and level. Locate vent piping at least 10 ft away from window, door or intake openings. Coordinate closely with roofing contractor to prevent damage to roofing membrane. Flashing shall be in accordance with requirements of roofing manufacturer.

H. Where interferences develop, offset or reroute piping as required to clear interferences. Coordinate locations of plumbing piping with piping, ductwork, conduit and equipment of other trades to allow sufficient clearances. Consult drawings for exact location of pipe spaces, ceiling heights, door and window openings, or other architectural details before installing piping.

I. Provide protective sleeve covering of elastomeric pipe insulation, where piping and/or fittings are embedded in masonry or concrete.

J. Maintain piping in clean condition internally during construction.

K. Mitered ells, notched tees, and orange-peel reducers are not allowed. Bushings are not allowed on threaded piping.

L. Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including required service space for this equipment, unless piping is serving this equipment.

M. Set cleanouts true and level and protect properly throughout construction.

N. Set floor drains true and level and protect properly throughout construction. Weep holes shall be filled with removable material and kept free from concrete and other debris during construction. Weep holes shall be cleaned out for final working order. Provide safing for floor drains installed in elevated slabs.

O. Provide plugs or caps for pipe openings during construction to prevent debris from entering pipe. Temporary plug shall be plastic cap or equivalent.

3.2 UNDERGROUND WARNING TAPE

A. Provide warning tape for exterior buried sewers per Section 20 05 53.

3.3 EXTERIOR GREASE INTERCEPTORS

A. Install interceptors in accordance with manufacturer's recommendations.

B. Minimum slope for tank inlet and outlet piping is 1%.

C. Install in dry excavation. Dewatering is permitted to maintain dry conditions. Inspect for leakage upon completion of backfilling.

D. Units shall be placed on level undisturbed soil, or approved compacted fill. Two 2" x 6" redwood grade boards shall be placed below tank side walls along length.

E. Covers shall be set to grade within 1/4" from finish surface or as directed by Owner's Representative and secured in place during backfilling process to maintain structural rigidity and form and to prevent ingress of foreign bodies into both the interceptor and drainage system.

F. Sidewall backfill which required to pass 2" screen material made up of dry soil, sand or gravel. Minimum 12" sides, from base to top. No parallel backfilling or compaction along length of sidewalls is permitted. No wheel or track loading on sidewalls.

G. When installing, unit will be filled to static water level with water to prevent movement and resist pressure of backfilling process.

3.4 TESTING

A. Refer to Testing paragraph of Section 20 0000 - General Mechanical Requirements.

B. Water test may be applied to system either in its entirety or in sections. Piping shall be tightly plugged and submitted to 10 ft head of water located at highest point. Provide separate standpipe above highest point being tested or extend system to obtain required 10 ft head of water. Head shall be maintained for at least 30 minutes before inspection starts.

C. Defective work or material shall be replaced or repaired as necessary and inspection and test repeated. Repairs shall be made with new materials. No caulking of threaded joints or holes will be allowed.

D. Do not backfill pipe until successfully tested.

E. Testing with air will not be allowed.

END OF SECTION 22 14 00

SECTION 22 14 14 - BUILDING SUBSOIL DRAINAGE

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section specifies pipe and materials to provide subsoil drainage system for building.

1.2 RELATED WORK

A. Section 20 05 20 - Excavation and Backfill

1.3 SUBMITTALS

A. Shop drawings on items specified herein.

PART 2 - PRODUCTS

2.1 PIPE, FITTINGS AND JOINTS

A. Interior Underground
   1. Polyvinyl Chloride(PVC):
      a. Pipe: Perforated, ASTM Specification D2729
      b. Joints: Primer, ASTM F656; solvent cement, ASTM D2564
      c. Cover: Polypropylene filter fabric, design flow rate ranges from 110 to 330 gpm per square foot when tested according to ASTM D4491

2.2 VALVES

A. Ball Valves:
   1. Acceptable manufacturers: Asahi, Chemtrol, Ipex, Plast-O-Matic, Spears or approved equal
   2. Size 3" and smaller: PVC body, full port, true union, Teflon seats, EPDM seals, socket ends. Ipex VX Series

B. Check Valves:
   1. Acceptable manufacturers: Asahi, Chemtrol, Hayward, Ipex, Spears or approved equal
      a. Size 3" and smaller: PVC body, ball check, EPDM seals, socket ends

2.3 FILTER FABRIC

A. Filter fabric shall be non-woven polypropylene fiber bonded at crossing points. Equivalent opening size (EOS) shall be 70 to 100 U.S. Standard sieve size, ASTM D4751. Fabric shall have water flow rate of 55 gal/min/sq. ft, ASTM D4491.

B. Fabric shall be Typar, Style 3401 by DuPont or Mirafi 140 by TenCate or approved equal.

2.4 STONE

A. Drainage stone shall be washed rock or gravel evenly graded with stone smaller than 2" size and larger than 3/4" size.

2.5 CLEANOUT

A. Manufacturers: Josam, Wade, Zurn or Smith approved equal to item listed in Cleanout Schedule in Section 22 06 00 - Plumbing Schedules.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install subsoil drainage system as shown on drawings and details. Placement of drainage stone shall be carefully done to prevent tearing of filter fabric. Pipe shall be pitched at grade of 2″ per 100 ft.

B. Install jointing systems for pipe to accomplish proper pipe alignment and pitch.

C. Handle and store filter fabric according to manufacturer's recommendations.

D. Only pipe in stone bedding shall be perforated. Extensions to cleanouts shall be solid pipe material.

E. Install filter fabric as envelope around pipe and stone as follows:
   1. Lay fabric in trench.
   2. Place stone in filter fabric.
   3. Level stone to proper grade and set perforated pipe on stone.
   4. Place remaining stone on side and top of pipe.
   5. Wrap filter fabric around and close with minimum 6″ lap.

F. Components (fabric, stone, pipe) form subsoil drain conduit.

G. Where subsoil drains are required to penetrate foundation work, sleeve subsoil drains and use non- perforated sections of piping and place prior to foundation work.

H. Install settling basins base on undisturbed soil with setting pad of level concrete to bed base, build up basin with standard sections and epoxy based concrete mortar joints. Adjust cover slab and access frame to align with poured floor level.

END OF SECTION 22 14 14

SECTION 22 15 00 – GENERAL SERVICE COMPRESSED AIR SYSTEMS

PART 1 GENERAL

1.01 RELATED SECTIONS

A. 22 61 14 – Laboratory Compressed Air

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Conform to applicable code for materials and installation of the Work of this section.

2.02 ACCEPTABLE PIPING MATERIALS

A. Alternate material for Shop Air Applications Only: Schedule 40 galvanized steel pipewith treaded 150-pound galvanized malleable iron fittings.

B. Alternate material for Shop Air Applications Only: Type L hard drawn copper tubingwith wrought copper sweat fittings, 95/5 tin antimony solder.

C. Viega ProPress is acceptable - only one manufacturer to be used per system. No mixing manufacturers is acceptable.

D. Laboratory & Instrument Air Applications:

1. See Section 22 61 14, Laboratory Compressed Air

2. Hard drawn ACR copper tubing with wrought copper sweat fittings. Tubing pre-washed, degreased and capped at both ends by manufacture. Fittings pre-washed, degreased and wrapped by the manufacturer. All joints brazed with 15% silver brazing conforming to AWS classification BCuP-5. Brazing shall be done with nitrogen purge to be prevent oxidation.

2.03 UNIVERSITY DESIGN GUIDELINES

A. Building (house) compressed air shall not be shared with the building pneumatic compressed air system for HVAC controls. Building (house) compressed air and HVAC pneumatic control air shall be separate stand-alone systems complete with their own dedicated compressors.

B. For laboratory and instrument air, provide oil filter with automatic drain, and refrigeratedair drier. For shop air applications, confirm requirements with users.

C. Valving: Compressed air systems shall be provided with manual isolation valves at the following locations:

1. At each floor where branch piping connects to a riser.

2. At the compressor.
3. At branch connections to mains.
4. Upstream of any equipment connected to compressed air.

D. Shop air systems typically require quick couple disconnect fittings for connection offlexible hoses. Confirm requirements with users.

E. Equipment:

Large house systems: Liquid ring type. (Nash or approved equal). Provide water saving circulation option with cooling water heat exchanger.

F. Requirements:

1. Drain Lines: Daylight to a conspicuous location. Plumb to sewer.
2. Hammer Arrestors: Install in a maintenance-accessible location for.

END OF SECTION 22 15 00

SECTION – 22 16 00 NATURAL GAS PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section specifies natural gas piping and accessories to 5 ft outside building wall.

1.2 RELATED WORK

A. Section 20 05 20 - Excavation and Backfill

B. Section 20 05 29 - Piping and Equipment Supporting Devices

C. Section 20 05 53 - Mechanical Systems Identification

D. Division 26 - Electrical

1.3 QUALITY ASSURANCE

A. Order piping with each length marked with manufacturer's name or trademark and type of pipe; with each shipping unit marked with purchase order number, metal or alloy designation, temper, size, and supplier's name.

B. Installed material not meeting specification requirements must be replaced with material that meets these Specifications without additional cost to Owner.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Promptly inspect shipments to insure material is undamaged and complies with specifications.

B. Cover pipe to prevent corrosion or deterioration while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends from damage. End caps shall remain in place. Protect fittings, flanges, and unions by storage inside or by durable, waterproof, above ground packaging.

C. Off-site storage agreements will not relieve Contractor from using proper storage techniques.

D. Storage and protection methods must allow inspection to verify products.

1.5 SUBMITTALS

A. Manufacturer's technical data for the following:
   1. Pipe and fittings
   2. Joints
   3. Valves
   4. Valve boxes
   5. Seismic Shutoff Valves
   6. Regulators
   7. Appliance connectors

B. Shop Drawings on items specified herein.

1.6 NATURAL GAS SERVICE

A. Refer to gas meter schedule on drawings.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials herein specified shall be new, unless otherwise noted.

2.2 BELOW GROUND PIPE, FITTINGS AND JOINTS

A. 2″ and Smaller:
   1. Pipe: Thermoplastic polyethylene tubing, PE 2406 or PE3408, ASTM D3350, SDR-11, rated for 80 psig working pressure at 73°F, ASTM D2513
   2. Fittings: ASTM D2683, socket fusion. Use transition fitting at joints between polyethylene tubing and steel with protective coating. Transition fittings shall have socket joint on polyethylene tubing side and plain beveled end on steel side.
   3. Joints: Socket fusion or butt fusion
   4. Trace Wire: No. 12, copper 600 V, THHN insulation

B. 2-1/2″ and Larger:
   1. Pipe: Thermoplastic polyethylene tubing, PE 2406 or PE3408, ASTM D3350, SDR-11, rated for 80 psig working pressure at 73°F, ASTM D2513
   2. Fittings: ASTM D3261, butt fusion. Use transition fitting at joints between polyethylene tubing and steel with protective coating. Transition fittings shall have butt joint on polyethylene tubing side and plain beveled end on steel side.
   3. Joints: Socket fusion or butt fusion
   4. Trace Wire: No. 12, copper 600 V, THHN insulation

C. Polyethylene (PE) Ball Valves:
   1. Complying with 49 CFR Part 192, ASTM D2513, ASTM F2897, and ASME B16.40
   2. Manufacturers: Broen, Kerotest or approved equal

D. Service Entrance Pipe:
   1. Same as above ground covered with flexible polymer film with coal tar and synthetic elastomeric coating of 36 mil thickness or extruded high-density polyethylene factory applied coating of 30 mil thickness. Wrap fittings with 10 mil polyethylene tape, ANSI A21.5, double layer, half-lapped. Minimum dielectric strength exceeding 12 kV. Use compatible primer below polymer film or polyethylene tape.

2.3 ABOVE GROUND PIPE, FITTINGS AND JOINTS (UNDER 5 PSIG)

A. 4″ and Smaller:
   1. Pipe: ASTM A53, Grade A or B, Type E, or ASTM A106, Grade B, standard weight, (Schedule 40), carbon steel
   2. Fittings: ASTM A197/ANSI B16.3 Class 150, black malleable iron, threaded
   3. Joints: Threaded
   4. Viega MegaPress is an acceptable fitting / material.

2.4 ABOVE GROUND PIPE, FITTINGS AND JOINTS (OVER 5 PSIG)

A. 2″ and Smaller:
   1. Pipe: ASTM A53, Grade A or B, Type E, or ASTM A106, Grade B, standard weight, (Schedule 40), carbon steel
   2. Fittings: ASTM A105/ANSI B16.11, 3000 lb. forged steel, socket weld
   3. Joints: Welded
   4. Viega MegaPress is an acceptable fitting / material

B. 2-1/2" and Larger:
   1. Pipe: ASTM A53, Grade B, Type E or S, standard weight, (Schedule 40), carbon steel
   2. Fittings: ASTM A234 Grade WPB/ANSI B16.9, standard weight, (Schedule 40), seamless, carbon steel, welded
   3. Joints: Welded
   4. Viega MegaPress is an acceptable fitting / material.

2.5 UNIONS

A. Steel Pipe, 2" and Smaller:
   1. Malleable iron, ground brass seat, 150 psi steam working pressure; Stockham Figure 694 or equivalent
   2. Forged steel, spiral wound gasket seats, ASTM A105, ANSI B16.5

2.6 FLANGES

A. Steel Pipe, 2-1/2" and Larger:
   1. ANSI 150 lb. class forged steel flanges, ASTM A105/ANSI B16.5. Standard bolt pattern, ANSI 150 lb. class 1/8" thick gasket, Type 304 stainless steel, spiral wound metal with graphite filler.

2.7 VALVES

A. Ball Valves:
   1. Acceptable Manufacturers: Nibco, Neles-Jamesbury, Apollo, Kerotest, and Watts approved equal to manufacturer's Figure number listed
   2. 2" and Smaller:
      a. Bronze body, threaded, quarter turn, chrome plated brass ball, large port, reinforced TFE seat and stem packing, blowout-proof stem, 250 psig LP-Gas, UL Listed, CSA certified. NIBCO T-585-70-UL.
      b. Carbon steel body, threaded, quarter turn, 2-piece design, 316 stainless steel ball and stem, full port, spiral wound 316 stainless steel and Teflon seats and seals, blowout proof stem, 800 psi CWP rated, lever handle, CSA certified. Jamesbury Fire-Tite, Series 2000 Style 23-22
      c. Carbon steel body, quarter turn, 3-piece design, chrome plated steel ball, full port, TFE seats and seals, blowout proof stem,1000 psi CWP, lever handle, CSA certified. Jamesbury Fire-Tite, Series 4000.
   3. 2-1/2" through 8":
      a. Carbon steel body, ASTM A216-WCB Class 150, quarter turn, carbon steel flanged ends, Type 316 stainless steel ball, stainless steel stem, PTFE seats and seals, API-6D test requirement. Apollo 88A-140-35-59-TD

B. Vented Gas Pressure Regulators:
   1. Acceptable Manufacturers: Fisher, Rockwell, Sensus, or American meeting capacity and performance as scheduled
   2. 2" and Smaller Venting: Cast iron body, aluminum spring case, plated steel spring, Nitrile diaphragm and disc, threaded, vent to exterior of building, 150 psi CWP, -20°F to 160°F, listed in compliance with ANSI Z21.80, Fisher **[S200 series][CS200 series][CS400 series]**.

2.8 VALVE BOXES

A. Acceptable Manufacturers: Acorn, Acudor, or approved equal

B. Valve Box: Acudor ARVB, recessed wall mounted, 12" by 12" by 4" size, 16 ga stainless steel

construction, continuous concealed piano hinge, lever latch or slide latch, #4 satin polish finish, holes for piping penetration

C. Valves: Ball valves as specified above, with lever handles, easily operated without tools.

D. Identification: Engraved plastic plate, "NATURAL GAS SHUTOFF VALVE". Refer to Section 20 05 53.

2.9 SEISMIC GAS SHUTOFF VALVE

A. Valve shall have manual reset, selected with minimum pressure drop based on 7" WC, positive closure, soft seal seating, visual open-close indicator and UL Certified.

B. Valve shall close within 5 seconds when subjected to horizontal, sinusoidal oscillation at peak acceleration of 0.3 G for period of 0.4 seconds.

C. Valve shall not close when subjected for 5 seconds to each of the listed horizontal, sinusoidal oscillations as follows:

Peak Acceleration	Period
0.4 G	0.1 seconds
0.08 G	0.4 seconds
0.08 FG	1.0 seconds

D. Valve shall be either threaded or flanged selected at maximum capacity with minimal pressure drop.

E. Manufacturers:
   1. Koso/California Valves, Tremble Tech Inc., Safe-T-Quake or approved equal
   2. The following are options available only on Koso/California Valves:
      a. Maximum pressure: 0.5 psi, 7 psi, 20 psi, and 60 psi
      b. Flanged ends: 2", 3", 4", and 6"
      c. Three-way valve (seismic shut-off for pneumatic controls. Dry air or Nitrogen ONLY)
      d. Electrical switch (seismic shut-off for electrical circuits)
      e. Remote actuator (use with panic switch, smoke/fire alarm)

2.10 METERS

A. Refer to drawing [EDIT].

2.11 APPLIANCE CONNECTORS

A. Appliance connectors shall be corrugated stainless steel tubing with protective exterior coating, brass valve with non-displaceable rotor, brass outlet fitting, and CSA certified. Connector length shall be as required to allow servicing of appliance. Inside diameter of connector shall be 3/8" for appliances up to 60,500 btu/h, 1/2" for appliances up to 106,000 btu/h. Connectors shall be Brass-Craft CSSD44 Series or CSSC44 Series.

2.12 CASEWORK FLEXIBLE GAS PIPING

A. 2" and Smaller:
   1. Tubing: Flexible gas piping shall be UL Listed, FM approved, 300 series corrugated stainless steel tubing (CSST) fabricated in accordance with ASTM A240 and conforming to ANSI/CSA LC-1. Tubing shall be suitable for operation with natural gas or LP (propane) gas.
   2. Fittings and Joints: Yellow brass mechanical fittings and joints with stainless steel AutoFlare pilot insert for ID tubing

3. Jacket: Fire retarded, UV resistant, extruded polyethylene with ASTM E-84 flame and smoke density rating of 25/50

B. Manufacturer: OmegaFlex TracPipe or approved equal

2.13 CATHODIC PROTECTION

A. Provide complete galvanic anode type cathodic protection system for underground steel gas piping, including devices to electrically isolate system being protected.

B. Corrosion protection system shall be provided by Contractor regularly engaged in installation and testing of cathodic protection systems. Contractor's personnel shall be experienced and shall be supervised by Engineer who is accredited as Corrosion Specialist by National Association of Corrosion Engineers. Calculations, design and testing shall be performed by Corrosion Specialist. Procedures shall conform to NACE Standards.

C. Submit catalog cuts and shop drawings for the following:
1. Anodes
2. Permanent Reference Cells
3. Cable and wire
4. Test stations
5. Terminal boxes
6. Isolating flanges, unions, coatings, easing seals
7. Exothermic welding devices
8. Layout drawings, wiring diagrams
9. Test instruments
10. Dielectric tape
11. Test connection points
12. Accreditation of Corrosion Specialists by National Association of Corrosion Engineers
13. Calculations from field survey, performed by Corrosion Specialist

D. Foreign Metallic Contacts:
1. No foreign metal shall be allowed to contact electrically isolated sections of pipe between flange insulators. Where pipe passes through building walls, manholes, valve pits, etc., caution shall be exercised to ensure that pipe does not contact reinforcing steel. Pipe anchors and supports shall not be permitted in contact with metallic structures. Flange insulators shall be placed as close as possible to building and manhole entrances to avoid shorting to other metallic members.
2. Upon completion of installation, system shall be tested to ensure system performance. One-year service agreement shall be included in base price. Cathodic protection system must be certified by NACE Accredited Corrosion Specialist.

E. Field Quality Control:
1. Provide system with calculated design life exceeding 40 yrs.
2. Corrosion Specialist shall perform soil resistivity survey. Survey shall include entire length of proposed right-of-way. Soil survey shall include soil pH and presence of chlorides. Stray current investigation shall also be conducted prior to cathodic protection design.
3. Corrosion Specialist shall provide engineering calculations to verify design of system. Calculations shall follow format published by recognized corrosion expert.
4. Corrosion Specialist shall inspect work at least twice to ascertain that there is no grounding, short circuits, coating damage, and that installation is in accordance with standards and methods specified herein.

PART 3 - EXECUTION

3.1 GENERAL

A. Install gas piping according to requirements of this Section, local gas utility, NFPA 54 National Fuel Gas Code, AGA pamphlets and as shown on drawings.

B. Piping through roof to be run through approved roof penetration with flashing and counter flashing.

C. Install buried/underground polyethylene gas piping with trace wire taped to pipe along its entire route. Secure wire to pipe to prevent movement during backfilling. Extend trace wire to valve boxes and service entrance.

D. Transition from polyethylene piping to steel piping shall occur below grade. Provide cathodic protection and corrosion protection pipe wrap for underground steel pipe.

E. Install underground polyethylene gas piping exterior to building according to pipe manufacturer's recommendations and to meet local gas utility company's installation standards.

F. Manufacturer's representative shall instruct workmen in proper techniques for installation of underground polyethylene gas piping and provide certification to Owner's Representative that instructions have been given and proficiency been demonstrated by Contractor for installation of that piping system. Joints must be made by "Qualified" personnel proficient in joining methods of ASTM D2513 thermoplastic gas pressure pipe.

G. Grounding to gas piping is prohibited.

H. Gas piping shall be installed with dirt legs adjacent to equipment and with drain tees and plugs at low points.

I. Gas piping in plenum ceilings shall have welded joints.

J. Install gas piping above ground in buildings. Gas piping shall not be installed below building floor or footings.

K. Pitch horizontal piping downward at 1" per 60 ft in direction of flow toward risers or appliances. Install minimum of 4" deep dirt leg at bottom of each vertical run and at each appliance. When installing mains and branches, cap gastight each tee or pipe end, which will not be immediately extended. Take branch connections to main from top or side of main.

L. Coat underground piping with corrosion resistant tape approved equal to Tapecoat H-30 and cathodically protected as specified herein. Repair breaks in tape coating caused by installation process.

M. Make threaded joints by cutting pipe square and reaming inside. Threads shall be cut so exposed threads do not exceed 3 in number. Protect exposed threads against corrosion. Use only joint compounds approved for gas piping.

N. Seismic shut-off valve must be installed upright, level, plumb, and downstream of regulator or main gas meter (prior to structure it protects). Valve must be rigidly mounted to earth foundation or structure so that seismic movements will be transmitted to acceleration trigger mechanism within valve assembly.

O. Do not exceed maximum torque (inch-pounds) specified by valve Manufacturer during installation

of seismic shut-off valve.

P. Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including the required service space for this equipment, unless piping is serving this equipment.

3.2 UNDERGROUND WARNING TAPE

A. Provide warning tape for exterior buried gas lines per Section 20 0553.

3.3 PRESSURE REGULATORS

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

B. Regulator shall be accessible for maintenance and protected from fire and mechanical damage. Regulator shall be supported from structure by brackets and supports.

C. Vent from relief valve shall be routed to outside. Terminate vent with protection screen and return bend. If above ground vent terminates in area subject to snow accumulation, terminate line at least 5 ft above grade. Coordinate vent routing with other trades to point of termination. Size vents in accordance with regulator manufacturer's requirements for regulator flow rate and length of run.

D. Provide unions on both sides of regulators for removal and maintenance.

E. Provide gas cock for pressure verification.

3.4 METERS

A. Verify transmission of signal to Building Automation System

3.5 VALVE BOXES:

A. Mount bottom of box at 60″ above finished floor. Adjust height as required to match wall material pattern.

B. Orient valve to allow closing the door when valve is both open and closed.

C. Seal pipe penetrations with silicone caulk.

D. Mount identification placard onto valve box door.

3.6 CONNECTIONS

A. Provide appliance connectors at ranges, ovens and other appliances, which require that they be relocated before accessing gas connection. Do not use appliance connectors for water heaters or for other equipment or appliances, which do not require that they be relocated before accessing gas connection.

B. Install shut off valve at each appliance. Provide valved connection at main for equipment and appliances furnished by others.

C. Shutoff valves shall be accessible in case of emergency; installed minimum of 5 ft from equipment. Provide shutoff valves at each piece of equipment.

3.7 WELDER QUALIFICATIONS

A. Welding procedures, welders, and welding operators for building service piping to be in accordance with certified welding procedures of National Certified Pipe Welding Bureau and Section 927.5 of ASME B31.9 Building Services Piping or AWS 10.9 Qualification of Welding

Procedures and Welders for Piping and Tubing.

B. Before metallic welding is performed, submit Welding Procedure Specification together with Procedure Qualification Record as required by Section 927.6 of ASME B31.9 Building Services Piping.

C. Before polyethylene fusion welding is performed, submit certification that welders to be used on this project have successfully demonstrated proper welding procedures in accordance with Code of Federal Regulations, Title 49, Part 192, Section 192.285.

D. Before welding is performed, submit Standard Welding Procedure Specification together with Procedure Qualification Record as required by Section IX of ASME Boiler and Pressure Vessel Code.

E. Welded joints shall be made in conformance with latest provision of Code for Pressure Piping, ANSI Standard B31-8 - Gas Transmission and Distribution Systems. Welds to be made by qualified welders experienced in piping work. Welding, piping fabrication, etc. shall be in accordance with ASME Code, State Codes, and Welding Manual of Mechanical Contractors Association of America.

F. Owner's Representative reserves right to test work of welder employed on Project, at Contractor's/Owner's expense. If work of welder is found to be unsatisfactory, welder shall be prevented from doing further welding on project and defective welds replaced at no additional cost to Owner.

3.8 TESTING

A. Test above ground steel gas piping with dry compressed air at 50 psi for 2 h. Soap test of each joint shall be done to detect leaks during 2 h period. No loss of pressure allowed during test period. No piping shall be concealed until successfully tested.

B. Test underground polyethylene gas piping at 50 psi with dry air for 2 h. No loss in pressure allowed. Defective joints shall be cut out, pipe repaired, and retested. No piping may be backfilled until successfully tested.

C. Types and extent of non-destructive examinations required for pipe welds are as shown in Table
136.4 of ASME Code for Pressure Piping, ANSI/ASME B31.1 - Power Piping. If requirements for non-destructive examination are to be other than that stated above, degree of examination, and basis for rejection shall be matter of prior written agreement between fabricator, or Contractor and purchaser.

D. Local regulating and governing agencies may require periodic testing of seismic valve's ability to shut-off gas flow during seismic event. Follow procedures specified by local governing agency for test.

3.9 CLEANING

A. Before actuation of gas system, flush system with dry nitrogen to ensure clean system free of oil and construction debris.

END OF SECTION 22 16 00

SECTION 22 21 14 - PLUMBING SPECIALTIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section covers material specialties for piping systems.

B. All components installed on water systems defined in Section 22 11 18 shall comply with NSF-372 to be compliant with requirement for lead content of <0.25% maximum weighted average.

1.2 RELATED WORK

A. Section 22 05 94 - Domestic Water Systems Balance

B. Section 22 11 18 - Water Distribution System

C. Section 22 13 14 - Sanitary Waste and Storm Drainage Systems

D. Section 22 15 00 - Industrial Compressed Air System

E. Section 22 61 14 - Laboratory Compressed Air System

F. Section 22 62 14 - Laboratory Vacuum Piping System

G. Section 22 66 53 - Corrosion Resistant Waste and Vent System

1.3 SUBMITTALS

A. Manufacturer's technical data for the following:
   1. Thermometers
   2. Pressure gauges
   3. Pressure relief valves
   4. Strainers
   5. Backflow preventers
   6. Flexible connections
   7. Air vents
   8. Trap primers
   9. In-line check valves
   10. Flashings
   11. Safings

B. Shop drawings on items specified herein.

C. Certificates: Submit performance testing certificates for reduced pressure backflow preventers and double check backflow preventers.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials herein specified shall be new unless otherwise noted.

2.2 THERMOMETERS

A. Manufacturers: Miljoco, Taylor, Trerice, Weksler, Winters and Weiss approved equal to Trerice numberlisted

B. Thermometers shall be 9” die cast aluminum case and frame, double strength glass window, adjustable angle stem, permanently stabilized glass tube with mercury free indicating fluid, readable

scale with gradations from 30°F to 240°F. Provide brass extension neck sockets of appropriate length. Trerice Series No. A400 (old catalog number BX91400).

2.3 THERMOMETER SOCKETS AND TEST WELLS

A. Brass construction with threaded connections suitable for thermometer bulbs and control sensing devices, well length suitable for pipe diameter with extended neck as required to suit pipe insulation. Trerice 5550 Series.

2.4 PRESSURE GAUGES

A. Manufacturers: Ashcroft, Marsh, Marshalltown, Miljoco, Taylor, Trerice, U.S. Gauge, Weiss, and Winters, approved equal to Trerice number listed

B. Pressure gauge shall be 4-1/2″ die cast aluminum case, double strength glass window, readable dial scale with gradations from 0 to 200 psi, phosphor bronze bourdon tube, brass socket. Provide shutoff valve with pressure gauge, Trerice Series No. 600.

C. Gauge accuracy shall meet ASME B40.1 Grade 1A (1% full scale).

D. Pressure gauges shall be calibrated for the following pressure ranges:
   1. Domestic Water: 0 to 160 psi at 2 psi increments
   2. Medical Air: 0 to 100 psi at 1 psi increments
   3. Oxygen: 0 to 100 psi at 1 psi increments
   4. Medical Vacuum: 30″ Hg at 0.2″ Hg increments

E. Pressure Snubbers:
   1. 1/4″ or 1/2″ size, matching gauge size, 1000 psig WP. Brass for copper or carbon steel pipe, stainless steel for stainless steel pipe.

2.5 PRESSURE RELIEF VALVE

A. Manufacturers: Cash-Acme, Consolidated, Kunkle, Lonergan, and Watts

B. Bronze body, resilient seat/seal, ASME Section VIII, stainless steel spring

C. Refer to Schedules on drawings for performance requirements.

2.6 STRAINERS

A. Manufacturers: Conbraco, Hoffman, Keckley, Metraflex, Mueller, Wheatley or approved equal

B. Strainers shall be comparable to regulator or control valve specified. Strainers shall be "Y" type for liquid service to 400 lbs. WOG at 210°F, with 40 mesh stainless steel screen. Body material shall be compatible with installed piping, stainless steel, or FDA approved, heat fused, epoxy coated interior.

2.7 BACKFLOW PREVENTER

A. Reduced Pressure Zone Backflow Preventers:
   1. Manufacturers: Wilkins
   2. 3/4″ through 2″: Bronze body, resilient check valve seats, shut-off valves, Y-pattern strainer with bronze body and stainless-steel screen, drain line air-gap fitting, bronze test cocks, certified in accordance with ASSE 1013 and AWWA C511, Wilkins 375XL.
   3. 2-1/2″ through 10″: Cast iron body, bronze trimmed check valves, shut-off valves, drain air-gap fitting, bronze test cocks, certified in accordance with ASSE 1013 and AWWA C511, Wilkins 375A.

2.8 TRAP PRIMERS

A. Refer to drawings for schedule.

2.9 IN-LINE CHECK VALVES

A. Manufacturers: Circle Seal Control, DFT, Inc., Apollo Division - Conbraco Industries or approved equal,

B. Bronze or bronze/stainless steel construction with spring loaded check (316 stainless steel spring) and straight through flow. Apollo Ball-Cone model 62-100 Series, or approved equal.

2.10 FLEXIBLE CONNECTIONS

A. Bronze, braided flexible hose or neoprene twinsphere connectors by Mason Industries with 150 psi WOG working pressure rating.

B. Alternate manufacturers are Redflex, Resistoflex and Flexonics or approved equal.

2.11 FLASHINGS

A. Elastomer Membrane Roofing:
   1. Pipe clamps, Fernco Series 1056 flex coupling with Series 300 stainless steel clamps.

B. Built-Up Roofing:
   1. 4 lb./ft^2 sheet lead, to 18" beyond drain perimeter.
   2. Preformed lead vent collar, 4 lb./ft^2 sheet lead, to 18" beyond vent perimeter; 18" minimum square base flange.
   3. Nobleflex roof drain flashing of Chloraloy and 20 lb./ft^2 asphalt saturated roofing felt bonded together.

2.12 SAFINGS

A. 4 lb./ft^2 sheet lead, to 18" beyond edge of drain on all sides.

B. Chlorinated polyethylene (CPE) as manufactured by Noble Company under trade name Chloraloy 240.

C. Polyvinyl Chloride (PVC) shower pan line, 40 mil thickness, ASTM D4551.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide thermometers where indicated on drawings. Thermometers shall be easily read from floor or maintenance platforms. Calibrate thermometers to insure accuracy.

B. Install pressure gauges where indicated on drawings. Gauges shall be easily read from floor or maintenance platforms. Provide extensions as required to make gauges easily readable. Calibrate gauges to insure accuracy.

C. Install backflow preventers as indicated on drawings. Flush debris from strainers. Certified tester shall test reduced pressure zone backflow preventers to verify that functions are operational. Route vent line to adjacent hub drain.

D. Install strainers for equipment including pumps, meters, backflow preventers, reducers and regulators, and as shown on drawings.

E. Install trap primer units as recommended by manufacturer and as indicated for priming drain traps. Insure positive air gap to protect against backflow. Install in-line trap sealer as recommended by manufacturer.

F. Install in-line check valves where specified or as indicated on drawings.

G. Install flexible connections for base mounted pumps and other vibrating equipment.

H. Install air vents at high points in water systems where air may collect.

I. Safing:
   1. Install safing for floor drains. Extend safing to 18″ from edge of drain. Safing shall be clamped to floor drain body and pitched to drain to weep holes. Floor drains installed in unexcavated areas do not require safing.
   2. Install safings for showers. Concrete floor shall be smooth and free of dirt. Seal joints per manufacturer's recommendations and turn up sides minimum of 6″ above curb or maximum water level. Safing shall clamp into drip pan of floor drain and be secured by flashing clamp to assure drainage into weep holes of drain body. Inside vertical corners of showers shall have 12″ strips 6 ft above floor, extend 6″ in each direction and bottom to overlap pan 3″.
   3. Membrane roofing material, preformed elastomer pipe pots, and flashing seams are provided by Roofing Contractor for pipe penetrations and drain flashing. Plumbing Contractor shall provide drain flashing clamps and stainless-steel strap clamps for piping penetrations. Coordinate with General Contractor to facilitate sealing drain flashing and pipe penetrations.

J. Flashing:
   1. Coordinate flashings on roof closely with Roofing Contractor. Install flashings as required to insure proper vapor barrier and as directed by Architect.
   2. Install flashing for roof drains and overflow drains. Flashing shall extend minimum of 18″ beyond edge of drain and shall be clamped into drain body.
   3. Use pre-molded flashing assembly for roof penetration of medical air intake piping. Install 1″ of insulation between flashing and outside of pipe.
   4. Use pre-molded flashing assembly with hood for roof penetrations of medical vacuum exhaust piping. Set bottom of hood at 24″ above finished roof.
   5. Roof penetrations for corrosive or acid vent systems shall be pre-formed EPDM vent pot with flex coupling pipe clamp collar.

3.2 TESTING

A. Safings shall be subject to standing water test to detect leaks and proper drainage to weep holes of floor drain.

END OF SECTION 22 21 14

SECTION 22 30 00 - PLUMBING EQUIPMENT

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. General Design Requirements

B. Water Heaters:

1. Commercial gas fired.

2. Commercial electric.

C. Domestic water heat exchangers.

1.02 GENERAL DESIGN REQUIREMENTS

A. Domestic Water System

1. Cold water systems will be sized using CPC flush valve curves, and hot water systems using flush tank curves. Equipment branches and main pipe size will be based on flow requirements without diversity.

2. All plumbing valves will be located behind a lockable access panel when they are in a concealed location.

3. Hose bibs will be provided on the roof of each building. The hose bibs will be spaced 50 ft apart, maximum.

4. Chrome plated stops with gasket seats will be provided for sinks, lavatories, and wash basins when exposed to public view. A hose bibb with vacuum breaker will be provided under the lavatories in each toilet room. Exposed branch water supply piping in toilet rooms and custodial rooms will be chromium plated.

5. Water hammer arrestors will be provided in the wall, as required, behind a lockable access panel. Trap primers from lavatory tailpieces or water closet flush-o-meter valves for floor drains will also be provided.

6. Isolation valves and unions at equipment connections will be provided.

7. The water piping will be designed to provide a minimum residual pressure at the most remote water closet of at least 30 psig. Pressure regulators will be installed to comply with California Plumbing Code.

a. The maximum water pipe velocity will be 5 ft/sec. for hot water and 8 ft./sec for cold water.

b. The minimum supply pipe size will be 1/2" for one plumbing fixture with a maximum flow of 1.25 gpm.

c. Fixture pipe sizes will be as follows: 1-1/2" for a flush valve water closet, 3/4" for a shower, 1/2" for sink and 3/4" for hose bibs.

8. Domestic water piping within the buildings will be “Viega” pro-press or approved equal copper tubing and shall conform to ASTM B 75 or ASTM B88, Fittings shall be copper in conformance with ASTM B16.18, ASTM B16.22 or ASTM B16.26. O-rings for copper press fittings shall be EPDM.22 32 00 Domestic Water Filtration Equipment.

B. Building Pure Water Systems

1. Building (house) pure water systems shall be designed to guarantee a water quality level of at least Lab Grade 3 per National Committee for Clinical Laboratory Standards (NCCLS) at all times. Individual laboratories requiring a guarantee of purer water shall install additional purification equipment in the laboratory as part of the building equipment (reference; Letter of Understanding dated 3-19-90, J. West; Physical Plant to K. McCaffrey; Natural Sciences).
2. The makeup water shall include pre-treatment consisting of a prefilter, a water softener, an activated carbon absorption filter, and a five (5) micron filter followed by treatment which shall consist of a reverse osmosis (RO) unit, mixed bed deionizer exchange service tanks, an ultra-violet light, and a 0.2-micron filter. Make up water capacity shall be determined in conjunction with sizing of the system storage tank.
3. The entire piping system shall be continually circulated. Dead legs shall be limited to drops to individual lab outlets. (Confirm maximum dead leg distance for each application) The entire circulating volume shall be exposed to ultra-violet light on each circulation. Provide dual stainless-steel circulation pumps to allow for continued circulation in the event of pump failure.
4. The system shall include a storage tank sized to allow make up to occur over a 12-hour period while accommodating maximum anticipated use with 20 % excess capacity. Determination of maximum system use shall include a diversity factors which shall be determined with the University’s Representative for each system.
5. The system shall include a side stream polishing loop which will continually circulate a portion of the water circulating through the system back through the mixed bed deionizers prior to return to the storage tank.
6. Provide a back-pressure valve on the return piping to the storage tank set to assure adequate pressure at the highest most laboratory faucet.
7. Provide pressure gauges on both sides of all filters and pumps.
8. Building (house) pure water systems shall be monitored by the Building Management System to provide alarms to the Physical Plant watch stander at the campus Central Heat Plant. Alarms shall be generated in the case of Water quality (conductivity) out of range, low tank level, and no flow.

C. Acceptable Piping Materials:

1. Socket fused polypropylene prepared specifically for deionized service. Pipe shall be sterilized and capped immediately after production. Fittings, valves, and unions shall be sterilized and individually wrapped immediately after production. Continuous trough support system.
2. Schedule 80 PVC with solvent weld fittings prepared specifically for deionized service. Pipe shall be sterilized and capped immediately after production. Fittings, valves, and unions shall be sterilized and individually wrapped immediately after production. Continuous trough support system. Stainless steel could be used in some applications.
3. Confirm piping material with the University's representative on a case by case basis.
4. Valves shall be diaphragm type.

D. Valving:

1. Pure water piping systems shall be provided with manual isolation valves at the following locations:
   a. At each floor where branch piping connects to a riser.
   b. On both sides of piping elements which may need to be removed for servicing including filters, pumps, ultraviolet lights, mixed bed deionizers, and RO Units.
   c. At branch connections to mains.
   d. Provide provisions for system drain down to a floor drain including drain down of storage

1.03 SUBMITTALS

A. See Division 1 for submittals procedures.

B. Product Data:

1. Provide dimension drawings of water heaters indicating components and connections to other equipment and piping.
2. Provide electrical characteristics and connection requirements.

C. Shop Drawings:

1. Indicate heat exchanger dimensions, size of tappings, and performance data.

D. Project Record Documents: Record actual locations of components.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

B. Certifications:

1. Water Heaters: NSF approved.

2. Gas Water Heaters: Certified by CSA International to ANSI Z21.10.1, as applicable, in addition to requirements specified elsewhere.
3. Electric Water Heaters: UL listed and labeled to UL 174.
4. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.01 WATER HEATERS

A. Manufacturers:
   1. A.O. Smith Water Products Co: www.hotwater.com
   2. Rheem Manufacturing Company: www.rheem.com

B. Commercial Gas Fired:
   1. Type: Automatic, natural gas-fired, vertical storage.
   2. Performance:
   3. Tank: Glass lined welded steel ASME labeled; multiple flue passages, 4-inch (100 mm) diameter inspection port, thermally insulated with minimum 2 inches (50 mm) glass fiber, encased in corrosion-resistant steel jacket; baked-on enamel finish; floor shield and legs.
   4. Accessories:
      a. Water Connections: Brass.
      b. Dip Tube: Brass.
      c. Drain valve.
      d. Anode: Magnesium.
   5. Certified for The Following Applications:
      a. Automatic storage water heater.
      b. Automatic circulating tank water heater.

C. Commercial Electric:
   1. Type: Factory-assembled and wired, electric, vertical storage.
   2. Performance:
   3. Electrical Characteristics:
   4. Accessories:
      a. Water Connections: Brass.
      b. Dip Tube: Brass.

c. Drain valve.

d. Anode: Magnesium.

5. Heating Elements: Flange-mounted immersion elements; individual elements sheathed with Incoloy corrosion-resistant metal alloy, rated less than 75 W/sq. in. (11.6 W/sq.m.).

2.02 DOMESTIC WATER HEAT EXCHANGERS

A. Manufacturers:

1. WCR: wcrhx.com; 1-800-421-4927

2. Or approved equal.

B. Plate Material: AISI 304L | AISI 316L | Titanium Gr1 | TiPd | H C276 | Ni200

C. Plate Thickness 0.5mm | 0.6mm

D. Gasket Material NBR | EPDM | HNBR | Viton® | Silicone VMQ® | Alfas®

E. Frame Material Carbon Steel | 304 Stainless Steel

F. Frame Finish Epoxy Coated | Powder Coated | Surface Prep 304

G. Tightening Rod B7 Grade Clear Zinc | B8 Grade Stainless

H. Connection Materials AISI 304L | AISI 316L | Titanium Gr1 | TiPd | H C276 | Ni200

I. Connection Type NPT Threaded | FPT Threaded | Tri-Clamp | Flanged

END OF SECTION 22 30 00

SECTION 22 31 00 - WATER CONDITIONING EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section lists equipment to be used to condition domestic water systems.

1.2 RELATED WORK

A. Section 20 07 00 - Mechanical Systems Insulation

B. Section 22 21 14 - Plumbing Specialties

1.3 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.4 SUBMITTALS

A. Shop drawings on items specified herein.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Culligan, Hellenbrand, U.S. Filter or approved equal

2.2 SOFTENER

A. Description: **[Single] [Duplex, twin alternating] [duplex, parallel] [triplex, alternating] [triplex, parallel]**, water softener shall include **[one] [two] [three]** fiberglass vessels with internal distributors, piping, fully automatic brass multi-port control valves, **[alternating controller]**, pressure gauges, sample valves, resin, gravel, outlet "Y" strainer, structural base, dry-brine maker and brine eductor. Unit shall be preassembled, prewired, and hydrostatically tested. Media shall be packaged separately.

B. Design Conditions:
   1. Design flow: Refer to equipment schedule
   2. Pressure: 30-80 psig
   3. Temperature: 50°F to 80°F

C. Design Criteria:
   1. Volumetric Flow Rate: less than 15 gpm/ft^3 at design flowrate
   2. Backwash Flow Rate: greater than 1.2 gpm/ft^3
   3. Maximum Hardness Leakage: 5 ppm (less than)
   4. Normal Hardness Leakage: 0 ppm

D. Resin:
   1. Type: Gel - strong acid cation
   2. Ionic Form Sodium
   3. Regenerant Chemical: NaCl saturated
   4. Regenerant Quantity: 15 gpm/ft^3 maximum
   5. Method of Chemical Introduction: Eductor
   6. Capacity/ft^3 (est.): 30,000 grains (as $CaCO_3$) at max salt dosage

E. Mechanical:
   1. Softener vessel:
      a. Material: Fiberglass **[Epoxy coated carbon steel]**
      b. Pressure Rating: 100 psig/150 psig
      c. Temperature Rating: 120°F
      d. Piping Connections: **[threaded][soldered]**
      e. Warranty: two years against interior, exterior and lining defects.
      f. Upper distributor: Single point baffle type, schedule 40 galvanized
      g. Lower distributor: hub and radial arm type, PVC or ABS
   2. Strainer: Bronze or PVC body with 20 mesh screen

F. Brine tank:
   1. Quantity: one
   2. Material: Polyethylene
   3. Salt Dose: 6-15 lb./ft^3

G. Electrical
   1. Controls: Motor-driven control valve shall stage each softener through regeneration steps. Regeneration shall be initiated by a signal from alternator controller. Regeneration frequency shall be based on throughput volume, totalized at common effluent of both softeners.
   2. 120 vac, 1 ph., 60 Hz power supply

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install water conditioning equipment level in location as shown on drawings. Support pipe to and from equipment from building structure; do not support piping from equipment.

B. Follow installation instructions of equipment manufacturer. Installation instructions shall always be at site.

C. Provide start up service by manufacturer or authorized representative.

D. Fill salt storage/brine tank after successful test results.

3.2 TEST

A. Operate equipment through regeneration cycle. Verify proper cycle time and brine injection.

B. After satisfactory performance of sequence of operation, take water samples of raw and conditioned water and send to lab to verify performance of the equipment.

3.3 BALANCING

A. Adjust equipment to work with minimum dosage of brine.

END OF SECTION 22 31 00

SECTION 22 40 00 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section lists plumbing fixtures and accessories including method of installation.

1.2 RELATED WORK

A. Section 22 11 18 - Water Distribution System
B. Section 22 13 14 - Sanitary Waste and Storm Drainage Systems
C. Section 22 16 00 - Natural Gas Piping
D. Section 22 61 14 - Laboratory Compressed Air System
E. Section 22 62 14 - Laboratory Vacuum Piping System
F. Section 22 63 14 - Nitrogen, Carbon Dioxide, and Specialty Gas Piping Systems
G. Section 11 53 43 – Laboratory Service Fittings and Fixtures
H. Section 22 66 53 - Corrosion Resistant Waste and Vent System

1.3 SUBMITTALS

A. One package of manufacturer's technical data for all items. Submittal shall be assembled brochure, showing cuts and full detailed descriptions for each item.
B. Shop drawings on items specified herein.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials as specified shall be new unless otherwise noted.
B. Vitreous china fixtures shall be of highest quality, non-absorbent, hard-burned, and vitrified throughout.
C. Enameled ware shall be quality cast iron of uniform thickness and density, glazed to uniform depth and high gloss rubbed smooth, without chips or flaws, craze, or cracks, and completely acid resisting.
D. Stainless steel fixtures shall be 302/304 types of non-corrosive steel, 18 ga self-rim for cabinet sinks, 14 ga for free standing compartment type sinks. Sink material shall have satin finish and coved corners, with faucet holes punched to match specified faucet fitting.
E. Insulation for traps and supplies shall be molded closed cell vinyl insulation and shall meet ASTM E84 for flame and smoke spread. Insulation shall be vandal resistant and be color as listed.

2.2 MANUFACTURERS

A. Plumbing fixtures shall be provided from list of approved manufacturers. Home Market, Generic Broker, or Wholesaler's house brands are not acceptable.
B. Water closets, urinals, and lavatories: American Standard, Zurn, Duravit, or Kohler approved equal to number listed
C. Water Closet Seats: Church, Bemis, Beneke, Centoco, Olsonite, or Zurn approved equal to number listed

D. Flush Valves: Zurn or Sloan approved equal to number listed
E. Stainless Steel Sinks: Elkay or Just approved equal to number listed
F. Electric Water Coolers: Elkay , Halsey-Taylor , Haws , Oasis , or Sunroc approved equal to model listed
G. Mop Basins (Janitor Sinks): American Standard , Fiat , Mustee , Stern-Williams , or Zurn approved equal to number listed
H. Emergency Eyewashes and Showers in non-finish area such as mechanical rooms are specified in plumbing documents: Haws , Acorn , Bradley , Encon , Guardian , or Speakman , approved equal to number listed.
I. Emergency Eyewashes and Showers are specified in Section 22 45 00 Emergency Plumbing Fixtures.
J. Manual Faucets: Kohler, Moen Commercial, Chicago Faucet, Zurn or approved equal to number listed
K. Sensor Activated Faucets: Moen Commercial, Bradley, or Zurn approved equal to model listed
L. Fixture Traps: Engineered Brass Company , Kohler , McGuire , or Zurn approved equal to number listed
M. Insulated Traps and Supplies: McGuire , ProFlo, or True-Bro approved equal to model listed
N. Supplies and Stops: Chicago Faucet , Kohler , McGuire or Zurn approved equal to number listed
O. Supplies and Stops: Brasscraft , Engineered Brass Company , Kohler , LSP Aqua-Flo or McGuire approved equal to number listed
P. Shower Valves and Mixing Valves: Symmons, Zurn, or approved equal to number listed

2.3 CARRIERS AND SUPPORTS

A. Carrier manufacturers shall be Josam , J.R. Smith , Wade , or Zurn , as outlined herein, with models suitable to fixture and use intended. Provide carriers with adjustable faceplate, rectangular steel uprights and at least 3 bolt lugs for securing carrier to floor. Adjustable water closet carriers shall be either right or left, single or double, horizontal or vertical as suggested by drawings and riser diagrams.

2.4 REFER TO SCHEDULE ON DRAWINGS FOR DETAILED FIXTURE SELECTION CRITERIA

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install plumbing fixtures as recommended by manufacturer. Caulk around fixtures mounted on irregular surfaces such as tile or stone with silicone sealant, same color as fixture.
B. Support fixtures with proper carrier for each use. Insure that carrier is solidly anchored to prevent rocking whatever piping is used. Anchor bolts in carrier foot shall extend 3″ minimum into concrete slab.
C. Fixture carriers shall be suitable for securing each plumbing fixture in place solidly, yet allowing its removal when necessary. Carriers shall be capable of mounting "Barrier Free" fixtures at suitable heights.
D. Install each fixture with trap easily removable for servicing and cleaning. Install fixture stops in readily accessible location for servicing.
E. Install barrier free fixtures in compliance with local code and Federal ADA Accessibility Guidelines. Install barrier free lavatory traps parallel and adjacent to wall and supplies and stops elevated to 27″ above finished floor to avoid contact by wheelchair users.
F. Return fixture waste and supply piping into wall as high as practical under fixture. Provide accessible

shutoff in fixture supply. Protect "barrier free" supply and drain piping with white colored wrap neatly trimmed to prevent contact with hot or sharp surfaces by user.

G. Coordinate with Electrical Contractor for electronic sensor wiring necessary to install "sensor" operated fixtures. Provide "shockstops" at supplies to solenoid activated fixtures.

H. Provide individual supplies to fixtures and rough-in fixture piping with adequate support to prevent movement fore, aft and laterally. Provide additional blocking as required.

I. Install flush valves for barrier-free water closets with operator handle facing wide side of toilet stall.

J. Provide unions at water connections to drinking fountains and electric water coolers.

3.2 LABORATORY BENCH AND CUP SINKS

A. Set fixture, faucet, eyewash, drain and tailpiece.

B. Make final waste, vent and water connections to fixture.

C. Purified water outlets do not require fixture stops.

3.3 LABORATORY CASEWORK OUTLETS

A. Set fixtures in predrilled casework.

B. Make final connection of fixture to service piping.

3.4 FUME HOODS

A. Set cup sink, faucet, drain and tailpiece.

B. Make final connections to service piping or pre-piped hood. Vent piping for cup sink will not be pre- piped.

3.5 PROTECTION

A. Protect finished surfaces of fixtures from accidental damage or discoloration by use of protective covering.

3.6 CLEANING

A. Prior to Owner acceptance, clean fixtures with compounds recommended by manufacturer and remove stains and marks from surrounding walls and countertops.

END OF SECTION 22 40 00

SECTION 22 40 00 - PLUMBING FIXTURES

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Water closets.

B. Urinals.

C. Lavatories.

D. Under-lavatory pipe supply covers.

1.02 RELATED REQUIREMENTS

A. Section 22 05 00 – Common Work Results for Plumbing

B. Section 22 10 05 – Plumbing Piping.

C. Section 22 11 16 – Domestic Water Piping

D. Section 22 13 00 – Facility Sanitary Sewerage

E. Section 22 30 00 – Plumbing Equipment

F. Section 22 45 00 – Emergency Plumbing Fixtures

G. Section 22 47 00 – Drinking Fountains and Water Coolers

1.03 SUBMITTALS

A. Product Data: Provide catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Potable Water Systems: Provide plumbing fittings and faucets that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.

2.02 WATER CLOSETS

A. At Student Apartments:

1. Toilet shall be 1.28 GPF vitreous china round front bowl, with direct flow priming jet and reverse trap. Hydraulic performance exceeding ANSI A112.19.2 requirements,

2. Seat: All plastic, closed front with cover, stainless steel hinge,

3. Campus Preference:

a. 1.28 HET Floor Mount Floor Discharge - American Standard 2234.001.020 1.1 -1.6

b. 1.28 HET Floor Mount Floor Discharge (ADA) - American Standard 3461.001.020 1.1 - 1.6

B. Public Restrooms (including dormitories):

1. Vitreous china, ASME A112.19.2, floor mounted, siphon jet flush action, china bolt caps.

2. Flush Valve: Exposed (top spud).

3. Flush Operation: Sensor operated.

4. Toilets shall be 1.28 GPF, wall hung with support carrier, vitreous china, elongated, flush valve type exceeding ANSI A112.19.2 requirements,

5. Campus Preference:

a. American Standard 2257.101.020 with Afwall 1.1 - 1.6 (1.28)

b. 1.28 GPF HET manual Toilet (No Piston Valve) - Zurn Z6000 AV Model

c. 1.28 GPF HET Sensor Toilet (No Piston) - ZER6000 CPM Model

C. Alternate water closet for single stall public rest rooms where light use is expected: Toilet shall be 1.28 GPF with hydro-pneumatic pressure assisted flush, vitreous china, floor mounted, elongated bowl, exceeding ANSI A112.19.2 requirements. Seat: All plastic, open front elongated without cover; stainless steel hinge.

D. Not Recommended Models:

1. Toilet: Zurn Z5615 Series, Zurn Z5655 Series, and Zurn Z5665 Series 1.28 GPF Elongated vitreous china toilet. The toilet bowls are too shallow for proper water scouring when flushed.

2. Toilet Seat: Elongated Open Front Seat - Bemis 1955SSCT

E. Flush Valves: ASME A112.18.1, diaphragm type, complete with vacuum breaker stops and accessories.

1. University Standard Manufacturer and Model: Zurn ZER600AV-CPM.

2.03 WALL HUNG URINALS

A. Urinals: Vitreous china, ASME A112.19.2, wall hung with side shields and concealed carrier.

1. Flush Volume: 0.125 GMP maximum.

2. Flush Valve: Exposed (top spud).

3. Flush Operation: Sensor operated.

4. Trap: Integral.

B. Flush Valves: ASME A112.18.1, diaphragm type, complete with vacuum breaker stops and accessories.

1. Sensor-Operated Type: Solenoid or motor-driven operator, infrared sensor with mechanical over-ride or over-ride push button.
2. Exposed Type: Chrome plated, escutcheon, integral screwdriver stop.
3. University Standard Manufacturer: Zurn

C. Carriers:

1. ASME A112.6.1M; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded fixture studs for fixture hanger, bearing studs.
2. University Preferred Manufacturers: Zurn, Josam, Mifab and J.R. Smith

D. Campus Standards, as appropriate for use/scope:

1. American Standard Washbrook 0.125 GPF FloWise Washout Top Spud Urinal, Model No. 6590001.020.
2. Zurn Z5758 “The Retrofit Pint” 0.125 GPF Ultra Low Consumption Urinal System (21” - 24" Footprint)
3. Zurn-ZER 6003-CPM Model Sensor Operated Battery Powered Flush Valve for %" Urinals (Note: Hard-wired is standard for new construction.)

2.04 TRAP ADAPTERS:

A. Campus Standard and Code Requirement: Use when waste line has a tubular trap. Purpose is to allow for easier maintenance.

B. Preferred Manufacturer and Model: Arrowhead Brass Products, #6001 A, 1-1/2’ M.I.P. x 1-1/2" Tube Size - Brass Nut, Brass Ferrule with stop. Male in Female UPC-1003.2. http://www.arrowheadbrass.com/products/

2.05 LAVATORIES AND FAUCETS

C. Vitreous China Wall Hung Basin: ASME A112.19.2; vitreous china wall hung lavatory, 20” by 18” inch minimum, with 4 inch (100 mm) high back, rectangular basin with splash lip, and front overflow.

1. University Preferred Manufacturers and Models:

a. Student Housing: Zurn Z5361, 20” by 18”, high back

b. Campus Standard: American Standard Lucerne 0355.012.020

D. Vitreous China Counter Top Basin: ASME A112.19.2; vitreous china self-rimming counter top lavatory, 19” round, with drillings on 4-inch (100 mm) centers, front overflow, soap depression, seal of putty, caulking, or concealed vinyl gasket.

1. University Preferred Manufacturer and Model:

a. Student Housing: Zurn Z5120 - Series, 19” round

E. Faucets:

1. Student Housing at lavatories: Heavy duty commercial grade single handle faucet; deck mounted with 4" center set, chrome plated finish, vandal resistant handle, brass body, washer less design, rotating ball control mechanism with replaceable nonmetallic seats and stainless-steel socket, vandal resistant 0.5 GPM flow restrictors spray outlet, left rod operated metal drain.

   a. Preferred Manufacturer and Model: Moen CA83005 Non-mixing Electronic Faucet (0.325 GPM Vandal Resistant Flow).

2. Student Housing at Kitchen Sink: Heavy duty commercial grade, single handle faucet, deck mounted with 8" centers, 8" swing spout, chrome plated finish, vandal resistant handle, brass body, rotating stainless steel ball control mechanism with replaceable non-metallic seats and stainless-steel socket, vandal resistant 2 GPM flow restrictor aerator.

3. Campus Preferred Faucets, Public Restrooms:

   a. Moen 8413 F03 Comm 4" cc .35 GPM

   b. Moen 8553 or 8554 Sensored

4. Faucet Maintenance:

   a. Use 0.50 GPM Tamper Resistant Laminar Flow Control for existing lavatory faucets: Neoperl 40.7059.733

2.06 UNDER-LAVATORY PIPE SUPPLY COVERS

A. General:

1. Insulate exposed drainage piping including hot, cold and tempered water supplies under lavatories or sinks per ADA Standards.

2. Construction: 1/8-inch (3.2 mm) PVC with antimicrobial, antifungal and UV resistant properties.

   a. Comply with ASME A112.18.9 for covers on accessible lavatory piping.

   b. Comply with ICC A117.1.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install components level and plumb.

END OF SECTION 22 40 00

SECTION 22 40 14 - EQUIPMENT BY OTHERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Items specified herein shall be provided by Plumbing Contractor to make equipment provided by others and Owner functional.

1.2 RELATED WORK

A. Section 22 11 18 - Water Distribution System
B. Section 22 13 14 - Sanitary Waste and Vent System
C. Section 22 16 00 - Natural Gas Piping
D. Section 22 21 14 - Plumbing Specialties
E. Section 22 66 53 - Corrosion Resistant Waste and Vent System

1.3 SUBMITTALS

A. One package of manufacturer's technical data for all items. Submittal shall be assembled brochure, showing cuts and full detailed descriptions for each item.
B. Shop drawings on items specified herein.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials specified herein shall be new unless otherwise noted.

2.2 OWNER FURNISHED EQUIPMENT

A. Where utility services are required for equipment connection, provide the following:
   1. Gas utilities services shall terminate with quick connect outlet; Hanson Coupling #3-HK.
   2. Pressure relief device between isolation valve and quick connect on pressurized gas services; Ross L-O-X Series 15.

2.3 DISHWASHER

A. Provide isolation valves on domestic water supplies. Refer to Section 22 11 18 for specific information.
B. Provide water hammer arrestors on domestic water supplies. Refer to Section 22 11 18 for specific information.

2.4 AUTOCLAVE

A. Provide isolation valves on industrial water supply. Refer to Section 22 11 18 for specific information.
B. Provide water hammer arrestor on industrial] water supply. Refer to Section 22 11 18 for specific information.
C. Provide indirect waste pipe from autoclave to local drain. Refer to Section 22 13 14.

PART 3 - EXECUTION

2.5 INSTALLATION

A. Plumbing Contractor shall install items specified herein as recommended by respective manufacturers. Final connections of waste, water, air, gas, etc., shall be installed by Plumbing Contractor as directed by equipment manufacturer. Incidental items, such as, adapters and unions required to make final connection shall be provided by Plumbing Contractor.

B. Coordinate rough-in sizes and elevations with equipment supplier before proceeding with work.

END OF SECTION 22 40 14

SECTION 22 45 00 – EMERGENCY PLUMBING FIXTURES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Emergency Eye Washes

B. Emergency Showers

1.02 RELATED REQUIREMENTS

A. Section 22 05 00 – Common Work Results for Plumbing

B. Section 22 10 05 – Plumbing Piping

C. Section 22 11 16 – Domestic Water Piping

D. Section 22 13 00 – Facility Sanitary Sewerage

E. Section 22 30 00 – Plumbing Equipment

F. Section 22 40 00 – Plumbing Fixtures

1.03 SUBMITTALS

A. Product Data: Provide catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Potable Water Systems: Provide plumbing fittings and faucets that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.

B. Locations where hazardous materials are used or stored shall be provided with emergency eye washes in compliance with California Code of Regulations, Title 8 (Cal OSHA) Section 5162, ANSI Z358.1 - 1990 and applicable ADA requirements.

C. Emergency eye washes and showers shall be supplied from the potable water system. Industrial water shall not be used to supply these fixtures.

D. Emergency eye wash and shower control valves shall remain open once activated until intentionally shut off.

E. Emergency eye washes and showers shall be located a distance no greater than 100 feet from the hazard and shall require no more than 10 seconds for an injured person to reach.

F. Floor drains shall not be provided at emergency showers in order to contain hazardous materials. The adjacent floor and walls should be designed to provide containment and also to

be resistant to water damage. The plumbing design professional should coordinate this issue with the project Executive Architect.

2.02 EMERGENCY EYE AND FACE WASH

A. Emergency Wash: ANSI Z358.1; wall-mounted, self-cleaning, non-clogging eye and face wash with quick opening, full-flow valves, stainless steel eye and face wash receptor, twin eye wash heads and face spray ring, stainless steel dust cover, copper alloy control valve and fittings.

PART 3 - EXECUTION

2.03 INSTALLATION

A. Install components level and plumb.

END OF SECTION 22 45 00

SECTION 22 47 00 – DRINKING FOUNTAINS AND WATER COOLERS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Electric water coolers.

B. Drinking fountains/Hydration Stations.

1.02 RELATED REQUIREMENTS

A. Section 22 05 00 – Common Work Results for Plumbing

B. Section 22 10 05 – Plumbing Piping.

C. Section 22 11 16 – Domestic Water Piping

D. Section 22 13 00 – Facility Sanitary Sewerage

E. Section 22 30 00 – Plumbing Equipment.

F. Section 22 40 00 – Plumbing Fixtures

1.03 SUBMITTALS

A. Product Data: Provide catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Potable Water Systems: Provide plumbing fittings and faucets that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.

2.02 DRINKING FOUNTAINS AND WATER COOLERS

A. Water Cooler: Electric, mechanically refrigerated; surface mounted, ADA compliant; stainless steel top, vinyl on steel body, elevated anti-squirt bubbler with stream guard, automatic stream regulator, push button, mounting bracket; integral air-cooled condenser and stainless-steel grille.

1. Capacity: 8 gallons per hour (30.3 liters per hour) of 50 degrees F (10 degrees C) water with inlet at 80 degrees F (27 degrees C) and room temperature of 90 degrees F (32 degrees C), when tested in accordance with ASHRAE Std 18.

2. Electrical: 115 V, 60 Hertz compressor, 6-foot (2 m) cord and plug for connection to electric wiring system including grounding connector.

B. Hydration Station:

1. Elkay Model LZWSSM Surface Mount or Haws 1212SF bottle filling station. Sanitary, touchless activation with auto 20-second shut-off.
    a. WaterSentry Plus 3000-gallon capacity filtration system, certified to NSF/ANSI 42 & 53 (Lead, Class 1 Particulate, Chlorine, Taste 7 Odor)
    b. Integrated silver ion anti-microbial protection
    c. Fill rate: 1.5 gpm; 1.1 gpm when connected to a remote chiller
    d. Laminar flow to reduce splash
    e. Real drain system
    f. Visual user interface display includes:
    g. Green Ticker counts bottles saved from waste
    h. LED visual filter monitor indicates when to replace filter
    i. Optional remote chiller can be installed within 15 feet of unit to deliver chilled drinking water.

2.03 EMERGENCY EYE AND FACE WASH

A. Emergency Wash: ANSI Z358.1; wall-mounted, self-cleaning, non-clogging eye and face wash with quick opening, full-flow valves, stainless steel eye and face wash receptor, twin eye wash heads and face spray ring, stainless steel dust cover, copper alloy control valve and fittings.

PART 3 - EXECUTION

2.04 INSTALLATION

A. Install components level and plumb.

END OF SECTION 22 47 00

SECTION 22 61 14 - LABORATORY COMPRESSED AIR SYSTEM

<NOTE TO REVIEWER: ALL COLORED AND BRACKETED TEXT SHOULD BE REVIEWED, EDITED, AND CONVERTED TO BLACK TEXT PRIOR TO PUBLICATION OF THESE SPECIFICATIONS>

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section covers piping and equipment required to provide laboratory grade compressed air as shown on plans and details.

1.2 RELATED WORK

A. Section 20 05 13 - Motors
B. Section 20 05 29 - Piping and Equipment Supporting Devices
C. Section 20 05 49 - Seismic Anchorage Restraints
D. Section 22 40 14 - Equipment by Others
E. Section 23 05 50 - Vibration Isolation
F. Section 26 29 13 - Enclosed Controllers
G. Items listed as “Cleaned for Oxygen Service” shall comply with requirements of CGA Standard G-4.1, Cleaning Equipment for Oxygen Service.

1.3 SUBMITTALS

A. Shop drawings on items specified herein.

1.4 PRODUCT DELIVERY

A. Deliver pipe and equipment properly packaged to protect against shipping and handling damage.
B. Installed pipe shall be sealed during construction to prevent construction debris from entering piping system.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials herein specified shall be new unless otherwise noted.

2.2 PIPE AND FITTINGS

A. Above Ground
  1. Copper
    a. Pipe:
      1) Copper tube, Type L hard temper, cleaned and capped, ASTM B819, marked "MED" or similar in accordance with ASTM
    b. Fittings: Wrought copper, solder joint, pressure rated, cleaned and bagged, ANSI B16.22
    c. Joints: Brazed, silver solder, BCu-3 or BCuP-5 type, AWS A5.8, 1250ºF melting point minimum.

2.3 UNIONS

A. Copper 3" and smaller:
   1. Wrought copper union, Nibco 633-W

B. Copper 4" and larger:
   1. Cast red brass flanges, alloy 844, ASTM B584, Class 150, ANSI B16.24 with neoprene gasket

2.4 VALVES

A. Ball Valves:
   1. Acceptable manufacturers: Nibco, Apollo, Watts OR APPROVED EQUAL
   2. 3" and Smaller:
      a. Full port, 2-piece, bronze body, chrome plated bronze ball, reinforced PTFE seats, blowout-proof stem, and threaded or soldered joint, NIBCO T/S-585-70.
   3. 2" and Smaller for Lock-out/Tag-out
      a. Conventional port, 2-piece, bronze body, stainless steel ball, Teflon seats and seals, stainless steel trim, blow-out proof stem, pad locking handle in closed position, automatic venting of downstream pressure in closed position, cleaned and bagged for oxygen service, 600 psi CWP; Apollo 75-140-41-57

B. CHECK VALVES
   1. Acceptable manufacturers: Apollo, Nibco, Watts OR APPROVED EQUAL
   2. 2" and smaller:
      a. Spring loaded, bronze or bronze/stainless steel body, 316 stainless steel spring, straight through flow, shipped bagged and oxygen clean. Apollo Ball-Cone Model62-100-57.

2.5 PRESSURE REGULATORS

A. Manufacturers: Cashco, Fisher, Jordan or approved equal

B. **[Bronze] [Stainless Steel]** body and spring case, direct acting valve, manual adjustment screw with top nut, stainless steel trim, resilient valve seat, cleaned for oxygen service. **[Valve shall be capable of XXX** cfm **with outlet pressure of XXX** psig **with inlet pressure of XXX** psig**.] [Cashco Model [D][DL][DA1] Series or approved equal.] [Jordan Mark 68G Series] [Refer to schedule on drawings for performance criteria.]**

2.6 AUTOMATIC DRAIN DEVICE

A. Acceptable manufacturers: Jorc or approved equal

B. Automatic condensate removal device with zero air loss during condensate discharge. Drain device shall have Viton seals and shall have 120 V power connection.

C. Basis of design is Jorc "Smart Guard Ultra" capable of up to 3600 scfm at up to 230 psig at 34-112°F.

2.7 OIL-LESS RECIPROCATING AIR COMPRESSOR

A. Manufacturers: Nash, Atlas Copco, Ingersol-Rand, or approved equal

B. Air compressors shall be triplex water cooled, single stage, oil-less reciprocating units piped in parallel. Compressors shall be **[base mounted, tank mounted]** and shall be factory wired, piped and tested prior to delivery to jobsite.

C. Compressors shall operate in lead/lag/alternate configuration. Panel for compressor control shall be included with package.

D. Each compressor shall be provided with following components:

1. 10-micron inlet filter
2. Air intake silencer
3. Discharge air check valve
4. Manual compressor isolation valve
5. Water cooled aftercooler
6. **[200] [230] [460]** V, 3 Ph motor meeting efficiencies listed in 20 0513
7. Capacity of **XXX** cfm at **XXX** psig
8. **[Simplex] [Duplex] [Triplex]** control panel shall be NEMA 4 rated enclosure with gauges, controls and indicators to monitor the following operations:
   a. One main fused disconnect
   b. **[One] [Two] [Three]** magnetic starters
   c. Automatic alternator with three position switch
   d. 120 V control transformer
   e. Compressor discharge pressure gauge
   f. Power indicator "ON" light
   g. High temperature shut-down switch
   h. Hand-of-auto switch
   i. Motor overload alarm
   j. Extra set of dry contacts for general alarm signal to building automation system

2.8 OIL-LESS ROTARY SCREW AIR COMPRESSOR

A. Manufacturers: Atlas Copco, Ingersoll-Rand, Kobolco, Quincy or approved equal

B. Air compressor**[s]** shall be **[simplex, duplex, triplex] [air cooled, water cooled] [single state, two stage]**, oil less rotary screw unit**[s] [piped in parallel]**. Compressor**[s]** shall be base mounted **[on frames with forklift slots][within sound enclosure]**. Compressor**[s]** shall be factory wired, piped and tested prior to delivery to jobsite.

C. Air compressor enclosure shall include vibration isolation meeting requirements of Section 23 0550 – Vibration Isolation. If enclosure cannot meet requirements of Section 23 0550, enclosure shall be provided with external isolators. Vibration isolator shall not be installed in series.

D. Compressors shall operate in lead/lag/alternate configuration. Panel for compressor control shall be included with package.

E. Each compressor shall be provided with following components:
   1. 10-micron inlet filter
   2. Air intake silencer
   3. Compressor unloading valve
   4. Discharge air check valve
   5. Manual compressor isolation valve
   6. **[Air] [Water]** cooled aftercooler
   7. Discharge air/water separator
   8. **[200] [230] [460]** V, 3 Ph motor meeting efficiencies listed in 20 0513
   9. Capacity of **XXX** cfm at **XXX** psig
   10. Compressor control panel shall be NEMA 4 rated enclosure with gauges, controls and indicators to monitor the following operations:
      a. One main fused disconnect
      b. Magnetic across-the-line starters with thermal overload protection
      c. Control functionality to start and stop multiple compressors in lead-lag-alternate sequence. Each compressor shall be capable of being master control machine.
      d. 120 V control transformer

e. Intercooler pressure
f. Compressor discharge pressure gauge
g. **[Air] [Water]** cooled aftercooler
h. First **[and second]** stage outlet air temperature
i. High first **[and second]** stage outlet air temperature alarm
j. High temperature shut-down switch
k. Power indicator
l. Run time hour indicator
m. Hand-off-auto switch
n. Motor overload alarm
o. Extra set of dry contacts for general alarm signal to Building Automation System

2.9 AIR RECEIVER

A. Manufacturers: Adamson, Brunner or approved equal

B. Air receiver shall be an ASME rated **[vertical] [horizontal]** vessel. Receiver shall have the following components:
1. **XXX-gal** capacity
2. **XXX** psig rated maximum working pressure
3. Maximum dimensions of **XXX**" diameter and **XXX**" height excluding base
4. Ring base with access hand holes
5. Inlet and outlet pressure gauges
6. Safety relief valve with soft seat
7. Automatic drain device
8. Outlet pressure regulating valve
9. Epoxy coated interior

2.10 REFRIGERATED AIR DRYER

A. Manufacturers: Arrow by McIntire, Deltech, Hankinson, Zeks or approved equal

B. Air dryer**[s]** shall be refrigerated unit**[s] [piped in parallel]**. Air dryer**[s]** shall be factory wired, piped and tested prior to delivery to jobsite.

C. Air dryer**[s]** shall be provided with following components:
1. **[Simplex] [Duplex]** inlet coalescing filter**[s]** with automatic drain device
2. **[Simplex] [Duplex]** outlet particulate filter**[s]**
3. Hot gas bypass
4. **[Air] [Water]** cooled condensing unit
5. Capacity of **XXX standard L/s at 4.4°C (scfm at 40°F)** dewpoint discharge air
6. **[120 V, 1 Ph] [240 V, 1 Ph] [208 V, 3 Ph]** power connection

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install compressed air piping as shown on drawings and details.

B. Provide low point drain valve at bottom of risers. Pipe mains shall not be trapped between connection at riser and last branch take-off. Branch take-offs to rooms or individual spaces shall be from top of main.

C. Provide flexible connections at compressor inlet and outlet connection points as shown on details.

D. Cut copper tube square and ream before assembly. Keep piping capped during construction to prevent intrusion of construction debris.

E. Support piping drops through finished ceiling from structure above to prevent any lateral or up/down movement. Other outlet drops shall be supported from walls, columns, or workbenches using appropriate hangers, anchors, or Unistrut.

F. Install unions on equipment side of shutoff valves for items such as: air dryers, receiver, compressors, filters, and similar equipment requiring periodic replacement or maintenance.

G. Install vented valve for lock-out/tag-out at connection to equipment. Vented valve shall meet OSHA requirements for disabling power source and bleeding downstream energy.

H. Install temporary plugs and caps on openings during construction phase.

3.2 COPPER TUBING

A. Copper tubing shall be installed per Copper Development Association guidelines in addition to methods specified herein.

B. Soldered Copper Joints:
   1. Use non-acidic and lead-free flux on cleaned pipe and fittings for soldered joints.
   2. Cut tube square, remove burrs from exterior of tube and ream interior of tube before assembly.
   3. Fill joints with solder by capillary action. Solder shall cover joint periphery. Wipe joint clean.
   4. Apply heat carefully to prevent damage to pipe, fittings and valves.
   5. Follow manufacturer's recommendations when heating valves and equipment for soldered connections.

C. Brazed Copper Joints:
   1. Brazed joints shall be ASTM Grade 4 or 5 and have melting point at approximately 1250ºF. Solder impurities shall not exceed 0.15%.
   2. Tubing shall be delivered to site with original mill caps in place.
   3. Cut tube square, remove burrs from exterior of tube and ream interior of tube before assembly.
   4. Joints shall be cleaned and polished before brazing.
   5. Flux of any type shall not be used.
   6. Apply heat carefully to prevent damage to pipe, fittings and valves. Disassemble valves where possible to prevent damage to seats during brazing.
   7. Purge tube with nitrogen during brazing procedure. Provide manual shut-off valve and check valve as required for purge gas.

3.3 AIR COMPRESSORS

A. Provide wiring necessary for controls and automation systems interface.

B. Air compressor package with components and accessories shall be furnished by one manufacturer. Install components according to manufacturer's recommendations. Consult manufacturer-furnished piping diagrams for interconnecting piping of system components.

C. Installation shall be inspected and approved by manufacturer's field representative. Equipment start-up shall be performed by manufacturer's representative in presence of Owner's Representative.

D. Air compressors shall be configured to operate in lead/lag/alternate sequence by pressure switch in receiver set to operate between 24 and 40 psig 50 and 65 psig 100 and 115 psig**.**

3.4 TESTING

A. Refer to testing paragraph of Section 20 0000 - General Mechanical Requirements.

B. Air piping shall be tested at 150 psig for 2 h prior to connection of laboratory fixtures. Soap test

each joint to detect leaks during test period. No loss of pressure allowed during test period. Defective joints shall be cut out and replaced. Air piping shall be re-tested at 100 psig for 8 h after final connection of laboratory fixtures.

C. Air compressor equipment shall be delivered pre-assembled and tested by equipment manufacturer.

D. Verify proper signal transmission for each condition specified to Building Automation Controller.

3.5 CLEANING

A. All pipe, fittings and valves will be cleaned by manufacturer. On- or off-site cleaning of any components by Contractor is not allowed. Any components, which have become contaminated, will not be used on any clean systems. They may be used in laboratory vacuum or any water system using copper pipe or fittings.

B. Before system is placed into use, flush piping with product air to remove foreign particles.

3.6 WARRANTY

A. Manufacturer shall warrant air compressor package and components complete, for period of 2 years from date of start-up.

END OF SECTION 22 61 14

SECTION 22 62 14 - LABORATORY VACUUM PIPING SYSTEM

<NOTE TO REVIEWER: ALL COLORED AND BRACKETED TEXT SHOULD BE REVIEWED, EDITED, AND CONVERTED TO BLACK TEXT PRIOR TO PUBLICATION OF THESE SPECIFICATIONS>

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section covers piping and equipment required to provide laboratory vacuum to lab outlets and vacuum pump equipment as shown on drawings for general laboratory vacuum outlets.

1.2 RELATED WORK

A. Section 20 05 13 - Motors
B. Section 20 05 29 - Piping and Equipment Supporting Devices
C. Section 20 05 49 - Seismic Anchorage and Restraints
D. Section 22 21 14 - Plumbing Specialties
E. Section 22 40 14 - Equipment by Others
F. Section 23 05 50 - Vibration Isolation
G. Section 26 29 13 - Enclosed Controllers

1.3 SUBMITTALS

A. Shop Drawings on items specified herein

1.4 PRODUCT DELIVERY

A. Deliver pipe and equipment properly packaged to protect against shipping and handling damage.
B. Installed pipe shall be sealed during construction to prevent construction debris from entering piping system.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials as specified shall be new unless otherwise noted.

2.2 PIPE AND FITTINGS

A. Above Ground
1. Copper
a. Pipe: Copper tube, Type L, hard temper, ASTM Specification B88
b. Fittings:
1) Cast copper alloy, solder joint, pressure rated, ANSI B16.18
2) Wrought copper or bronze, solder joint, pressure rated, ANSI B16.22
c. Joints: Lead free (<0.2%) solder, Bridgit or Silvabrite, ASTM B32; flux, ASTM B813 or Viega Pro Press

2.3 FLANGES

A. Copper:
   1. Cast red brass, Alloy 844, ASTM B584, Class 150 (150 psig), Standard bolt pattern, ANSI Standard B16.24 with neoprene gasket

2.4 VALVES

A. Copper Piping Systems:
   1. Manufacturers: The following list of valve manufacturers is acceptable unless otherwise noted subject to providing valves approved equal to items specified: Nibco, Apollo, Watts or approved equal
   2. Size 4" and Smaller:
      a. Ball Valves: Full port, 3-piece bronze body, quarter turn, stainless steel ball and stem, Teflon seats, blowout-proof stem, 600 psi CWP rated, screwed or soldered joint. NIBCO T/S-595-Y-66 or Apollo 92-240 Series

2.5 DIELECTRIC FITTINGS

A. Dielectric Flanges (3" and Larger)
   1. Acceptable Manufacturers: Epco Sales Inc., Lochinvar, Watts, Wilkins, Viega or approved equal
   2. Iron female pipe thread to copper solder joint end connections, non-asbestos gaskets, pressure rating of not less than 175 psig at 180ºF.

2.6 ROTARY VANE VACUUM PUMP SYSTEM

A. Acceptable Manufacturers: Beacon Medaes, Busch, Rietchle-Thomas, Becker, Air-Tech or approved equal

B. System Description:
   1. Vacuum pump package will be skid mounted and will include receiver tank, vacuum pumps, motors, all electrical components, valves, and piping.
   2. Vacuum pumps will be **[duplex] [triplex]** configuration and a single ASME Rated vertical vacuum receiver. Each vacuum pump will be independently mounted having independent flexible connectors on inlet and outlet of each pump.
   3. Pump package will have single points of connection for vacuum, vacuum exhaust, and electrical. Electrical feed will be **[208] [240] [480]** V, 3 Ph service. Transformers for devices requiring additional voltage supply will be provided with package.
   4. Vacuum pumps will be air cooled, rotary vane, single stage. Pumps will be direct drive, positive displacement, non-pulsating type. Each pump will have the following:
      a. Totally enclosed, fan cooled (TEFC), continuous duty motor. Suction line 5-micron filter, isolation valve, and liquid filled vacuum gauges with isolation valves.
      b. Integral piping and fittings for all components. All pump connections will have flexible connectors.
      c. Each pump suction will be manifolded to one 150 lb. (150 psig) flanged connection.
      d. Automatic purge system to flush any gases from pump and prevent condensation as pump cools. Purge system will include isolation valve and actuator, solenoid bleed valve, and controls to operate a 15-minute shutdown purge.
      e. Pump drain manifold, piped from each pump oil drain valve.
      f. Materials of Construction
         1) Vacuum pump: Cast iron casing, non-metallic, non-asbestos vanes, oil lubricated bearings, single mechanical seals
         2) Piping: Schedule 40 carbon steel per ASTM A-53 Grade B, threaded 2" and

smaller, flanged or welded for piping larger than 2"

3) Base plate: Carbon Steel

C. Pump lubrication will be by an integral, fully recirculating oil supply including oil filter.

D. Vacuum system will be controlled by skid-mounted packaged control system. Programming of vacuum system will be by system vendor. Local **[duplex] [triplex]** Programmable Logic Controller (PLC) will include:

1. UL Listed NEMA 12 Enclosure with across line magnetic starters, circuit breakers, one main fused disconnect, hour meters for each pump
2. Lead-lag pump alternator to control pumps so each pump receives approved equal run time and rotates through lead pump position, and capability for simultaneous pump operation.
3. Hand-off-auto switch for each pump
4. Manual purge/stop-auto switches for each pump
5. One hundred fifteen-volt control transformer with fused primary and secondary
6. Differential type vacuum control switches, field adjustable pump run meters, pump run and alarm lights and audible alarm with silence button, and vacuum gauges, and water temperature read-out devices for each pump, and terminal strip for external conditions.
7. All contacts, vacuum switches, relays, and other necessary accessories. Include extra dry contacts to signal Utility Monitoring System PLC of vacuum switch trips and equipment failures.
8. Frequent start protection with automatic pump shutdown.

E. Vacuum receiver will be ASME rated for 30" Hg vacuum, galvanized steel. Tank shall be fitted with inlet and outlet flange connections, level gauge, vacuum gauge with isolating valve, sight gauge glass, and tank drain valve. Tank drain valve shall have discharge pipe routed to skid perimeter.

F. Vacuum pump skid shall include vibration isolation meeting requirements of Section 23 0550 – Vibration Isolation. If skid cannot meet requirements listed in Section 23 0550, skid shall be manufactured without vibration isolators and external isolation shall be provided. Vibration isolators shall not be installed in series.

G. System Capacity

1. Refer to schedule on drawings for vacuum pump operating capacities and criteria.

2.7 WARRANTY

A. Complete system shall be warranted by manufacturer for 2 years from date of startup. Pumps shall be warranted by manufacturer for **[XXX]** years from startup. This warranty will include parts and labor on items returned to factory for repair and/or replacement. Labor costs associated with on- site warranty repairs shall also be covered by manufacturer and Contractor for minimum 1 year from date of startup.

B. Complete vacuum pump system shall be completely factory assembled and factory pre-tested prior to shipment to job site.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install vacuum piping as shown on drawings and details.

B. Provide low point drain valve at bottom of risers. Pipe mains shall not be trapped between

connection at riser and last branch take-off. Branch take-offs to rooms or individual spaces shall

be from top of main.

C. Provide line size cleanout plug at end of corridor distribution mains for flushing out piping.

D. Base-mounted pumps shall be anchored to structure in accordance with seismic restraint requirements. Refer to Section 20 05 49 - Seismic Anchorage and Restraints.

E. Provide vibration isolators for base or skid-mounted pumps.

F. Provide wiring necessary for float control switches, safety switches, solenoid valves, and controls interface required. Coordinate power requirements with Electrical Contractor.

G. Flexible connections shall be provided as shown on drawings.

H. Installation shall be inspected and approved by manufacturer's field representative. Equipment start- up shall be by manufacturer's representative in presence of Owner's representative.

3.2 PIPING SYSTEMS

A. Piping for Laboratory Vacuum system shall be copper.

3.3 COPPER TUBING

A. Copper tubing shall be installed per Copper Development Association guidelines in addition to methods specified herein.

B. Soldered Copper Joints:
   1. Use non-acidic and lead-free flux on cleaned pipe and fittings for soldered joints.
   2. Cut tube square, remove burrs from exterior of tube and ream interior of tube before assembly.
   3. Fill joints with solder by capillary action. Solder shall cover joint periphery. Wipe joint clean.
   4. Apply heat carefully to prevent damage to pipe, fittings and valves.
   5. Follow manufacturer's recommendations when heating valves and equipment for soldered connections.

C. Mechanical formed Tees
   1. Copper pipe may utilize mechanically formed tee fittings by use of T-drill machine, UL Listed method, ANSI B31.
   2. Joints for mechanically formed tees in copper system shall be brazed in accordance with American Welding Society lap joint weld, and Copper Development Association Copper Tube Handbook using BCup Series filler metal (Note: Soft soldered joints are not permitted.)

3.4 VACUUM PUMPS

A. Provide wiring necessary for controls and automation system interface.

B. Vacuum pump package with components and accessories shall be furnished by one manufacturer. Install components according to manufacturer’s recommendations. Consult manufacturer furnished piping diagrams for interconnecting piping of system components.

C. Installation shall be inspected and approved by manufacturer’s field representative. Equipment startup shall be performed by manufacturer’s representative in presence of Owner’s Representative.

D. Vacuum pumps shall be configured to operate in lead/lag/alternate sequence by pressure switch in receiver set to operate between **[19” and 23”][23” and 27”][25” and 29”]** of mercury vacuum.

3.5 CLEANING

A. Before system is in use, flush piping with dry compressed air to remove foreign particles.

3.6 TESTING

A. Refer to testing paragraph of Section 20 00 00 - General Mechanical Requirements.

B. Vacuum piping shall be tested at 200 psi for 2 h prior to connection of laboratory fixtures. Soap test each joint to detect leaks during test period. No loss of pressure allowed during test period. Vacuum piping shall be re-tested at 100 psi for 8 h after final connection of laboratory fixtures.

C. Vacuum pump equipment shall be delivered un-assembled and pre-tested by equipment manufacturer.

D. Verify proper signal transmission for each condition specified to Building Automation Controller.

END OF SECTION 22 62 14

SECTION 22 63 14 - NITROGEN, CARBON DIOXIDE AND SPECIAL GAS PIPING SYSTEMS

<NOTE TO REVIEWER: ALL COLORED AND BRACKETED TEXT SHOULD BE REVIEWED, EDITED, AND CONVERTED TO BLACK TEXT PRIOR TO PUBLICATION OF THESE SPECIFICATIONS>

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section specifies nitrogen, carbon dioxide and special gases, piping and related accessories. Special gas piping system shall include distribution of gases from gas cylinder central manifolds, and from localized point-of-use gas cylinder manifolds to terminal devices at individual points of use throughout the building.

B. (Special gases shall include but not be limited to Helium, Hydrogen, Oxygen, and Argon).

1.2 RELATED WORK

A. Section 20 05 29 - Piping and Equipment Supporting Devices

B. Section 20 05 53 - Mechanical Systems Identification

C. Section 22 40 14 - Equipment by Others

D. Section 22 62 14 - Laboratory Vacuum Piping System

E. Section 22 61 14 - Laboratory Compressed Air System

1.3 REFERENCE

A. Items listed as "Cleaned for Oxygen Service" shall comply with requirements of CGA Standard G- 4.1, Cleaning Equipment for Oxygen Service.

1.4 SUBMITTALS

A. Shop drawings on items specified herein.

PART 2 - PRODUCTS

2.1 PIPE

A. Above Ground:

1. Copper
   a. Pipe:
      1) Copper tube, Type L, hard temper, cleaned and capped, ASTM B280, and marked "ACR" or similar in accordance with ASTM
   b. Fittings:
      1) Cast copper alloy, solder joint, pressure rated, cleaned and bagged for oxygen service, ANSI B16.18 or Viega Pro Press
      2) Wrought copper or bronze solder joint, pressure rated, cleaned and bagged for oxygen service, ANSI B16.22
   c. Joints: Brazed, silver solder, BCuP-5 type, AWS 5.8, 1250ºF melting point minimum
2. Stainless Steel
   a. Pipe: Stainless steel tubing, Type 316, ASTM A269, hardness not to exceed Rb80, fully annealed, seamless tubing, free of scratches, burrs and surface defects, suitable for bending and flaring for sizes 1/16" through 2", cleaned for oxygen service. Minimum pipe wall thickness shall meet the following requirements:

Pipe Size (")	Minimum Wall Thickness (")	Maximum Working Pressure (psi)
1/8	0.028	8500
1/4	0.028	4000
3/8	0.049	4800
1/2	0.065	5100
5/8	0.065	4000
3/4	0.065	3300
1	0.083	3100
1-1/4	0.120	3600
1-1/2	0.134	3400
2	0.188	3600

b. Fittings and Joints: Type 316 stainless steel, double ferrule, compression by male, or compression by female tubing fittings, cleaned and bagged for oxygen service.
   1) Acceptable manufacturers: Parker, Swagelok, SSP Instrumentation, Tylok

2.2 FLEXIBLE CONNECTORS

A. Acceptable Manufacturers: Saint-Gobain or approved equal

B. Teflon smooth inner tube with outer 304 stainless steel braid, stainless steel crimped on end connections, -100ºF to 450ºF continuous temperature rating, 500 psig maximum working pressure, cleaned and capped for oxygen service.

C. Saint-Gobain TS series with **[XXX]** ends.

2.3 UNIONS

A. Copper 3" and smaller:
   1. Wrought copper union, cleaned and bagged for oxygen service, Nibco Fig. 633-W. Mueller brass or approved equal.

B. Copper 4" and larger:
   1. Cast red brass flanges; alloy 844 ASTM B584, Class 150, ANSI B16.24 with neoprene gasket, cleaned and bagged for oxygen service

C. Stainless Steel 2" and smaller:
   1. Swagelok Type 316 stainless steel, double ferrule tubing coupling, cleaned and bagged for oxygen service

2.4 VALVES

A. Copper:
   1. Ball Valve
      a. Size 2" and Smaller:
         1) Acceptable manufacturers: Nibco, Apollo, Watts or approved equal
         2) Full port, 3-piece, stainless steel ball, PTFE seats, stainless steel trim, blow-out proof stem, 6" tube extension, oxygen clean and bagged, quarter turn handle, 600 psi CWP rated, NIBCO CS-595-YX-66.
      b. Size 3" and Larger:
         1) Acceptable manufacturers: Nibco, Jamesbury, Watts, Worcester or approved equal
         2) Full port, stainless steel body and trim, quarter turn lever handle, 150 lb. class flanged ends, Teflon seats and seals, end entry, ductile iron handle wrench, oxygen cleaned and bagged, 150 psi CWP. Nibco F-510-S6-R-66-FS.

2. Butterfly Valve
   a. Size 3" and Larger:
      1) Acceptable manufacturers: Nibco, Apollo, Kennedy, Watts or approved equal
      2) Ductile iron body, lug design, aluminum bronze or stainless-steel disc, stainless steel stem, molded-in EPDM liner, Class 150 ANSI B16.1 flange ends, suitable for dead end shut-off to 175 psi with no downstream flange attached; oxygen cleaned and bagged, memory stop with locking device, lever actuator through 4", gear operator 5" and larger. NIBCO LD2022.

2.5 PRESSURE REDUCING VALVES

A. Acceptable Manufacturer: AGA/Linde, Norgren, Tescom or approved equal

B. Regulator shall be made from high purity brass or stainless steel barstock and have Hastelloy diaphragms. Regulator shall be cleaned and bagged for oxygen service. Regulator shall have 0- 80 psig outlet pressure range and be provided with outlet pressure gauge. Gauge shall be selected such that operating pressure is in center of gauge pressure range. Inlet and outlet connections shall be 1/4" female NPT minimum.

C. Refer to schedule on drawings for flow rate and pressure requirements of each regulator.

2.6 FILTERS

A. Coalescing Filters
   1. Acceptable Manufacturers: Balston, Dominick Hunter, Matheson, Pall, or approved equal
   2. Filter element shall be 99.99% efficient at 0.1 micron and capable of **[XXX]** scfm at **[XXX]** psig with **[XXX]** psig pressure drop when clean.
   3. Filter housing shall be stainless steel with auto-drain device, viton seals, and berated for 250 psig working pressure. Pipe discharge from auto-drain to nearest floor drain. Housing shall be cleaned and bagged for oxygen service
   4. Balston Grade BX with Model 45S6 housing.

B. Particulate Filter
   1. Acceptable Manufacturers: Balston, Dominick Hunter, Matheson, Pall, or approved equal
   2. Filter element shall be 99.99% efficient at 0.1 micron and capable of **[XXX]** scfm at **[XXX]** psig with **[XXX]** psig pressure drop when clean.
   3. Filter housing shall be stainless steel with viton seals and be rated for 250 psig working pressure.
   4. Balston Grade AQ with Model 45S6 housing.

2.7 SPECIAL GAS MANIFOLDS

A. Argon, Compressed Air, Helium, Nitrogen, Oxygen
   1. Acceptable manufacturers: AGA/Linde, Concoa, Matheson OR APPROVED EQUAL,
   2. Manifolds shall be high-purity semi - automatic style suitable for gas purities up to 99.999 percent and be cleaned for oxygen service. Manifold shall accommodate one primary cylinder and one secondary cylinder with automatic changeover from primary cylinder to secondary cylinder. Manifolds shall include:
      a. Regulators shall be manufactured from high purity brass barstock materials and contain a brass diaphragms.
      b. Manifolds shall be suitable for inlet pressures up to 3000 psig and deliver gas in the range of 0-125 psig.
      c. Manifolds shall be equipped with purge valves to allow purging of cylinders while in use. Flow limiters shall be provided on purge lines.

d. All manifold valves shall be 1/4 turn ball valves.
e. Manifolds shall include stainless steel **[braided flexible connectors] [pigtails]** with appropriate CGA fittings.
f. Manifolds shall have gauges with inductive style contacts for alarm signals.
g. Relief valve for protection of manifold from overpressure. Relief valve shall accommodate maximum flow from failed regulator while maintaining system pressure or below design pressure.

3. Changeover from primary to secondary supply shall take place automatically when primary supply becomes depleted. When depleted bank of cylinders is replenished, actuation of a clearly marked, easily operable lever on each bank regulator shall cause replenished bank to become secondary or reserve supply without requiring opening or closing of multiple bypass valves. Repositioning of operating levers shall expose indicator labels that clearly show if manifold has been properly reset and which bank is primary supply and which is secondary supply.
4. Manifold shall be set to deliver gas at listed pressures:
   a. Argon: **XXX** psig
   b. Compressed Air: **XXX** psig
   c. Helium: **XXX** psig
   d. Nitrogen: **XXX** psig
   e. Oxygen: **XXX** psig

B. Gaseous Carbon Dioxide **[from liquid cylinders]**

1. Acceptable manufacturers: AGA/Linde, Concoa, Chart, Matheson, Linde Electronics and Specialty Gases OR APPROVED EQUAL
2. Manifolds shall be high-purity semi - automatic style suitable for gas purities up to 99.999 percent. Manifold shall accommodate **[one] [two]** primary cylinder**[s]** and **[one] [two]** secondary **cylinder[s]** with automatic changeover from primary cylinder**[s]** to secondary cylinder**[s]**. Manifolds shall include:
   a. Regulators shall be manufactured from high purity brass barstock materials and contain a brass diaphragms.
   b. Manifolds shall deliver up to 1200 scfh $C0_2$ at an outlet pressure of 75 psig.
   c. All manifold valves shall be 1/4 turn diaphragm style with stainless steel diaphragm
   d. Manifolds shall include stainless steel **[braided flexible connectors] [pigtails]** with appropriate CGA fittings.
   e. Manifolds shall have inductive style contact gauges to be used by alarm system if required.
   f. The manifolds shall incorporate an economizer gas control circuit.
   g. The manifold shall incorporate 1000-watt gas heaters to prevent regulator malfunctions.
3. Changeover from primary to secondary supply shall take place automatically when primary supply becomes depleted. When depleted bank of cylinders is replenished, actuation of a clearly marked, easily operable lever on each bank regulator shall cause replenished bank to become secondary or reserve supply without requiring opening or closing of multiple bypass valves. Repositioning of operating levers shall expose indicator labels that clearly show if manifold has been properly reset and which bank is primary supply and which is secondary supply.
4. Manifold shall be set to deliver CO_2 at **XXX** psig.

C. Toxic Gas Cylinder Cabinet

1. Acceptable Manufacturers: AGA/Linde, Matheson, Linde Electronics and Specialty Gases or approved equal

2. Toxic gas cylinder shall accommodate one primary, one reserve, and one purge gas cylinder in single exhausted cabinet.
3. Cabinet:
   a. Painted steel cabinet with integral exhaust connection.
   b. Cabinet doors shall have fire-rated vision glass and louvers for air flow from surrounding space. Cabinet doors shall be self-closing and gasketed with locking latches.
   c. Cabinet interior shall include Unistrut mounting rails and cylinder clamps with the down straps.
   d. Cabinet shall be provided with automatic sprinkler head rated at 155ºF.
   e. Cabinet shall be provided with opening to accommodate gas leak detection device provided by others.
   f. Cabinet shall have PLC controller for all critical process functions. Controller shall have spare inputs and outputs for remote alarm monitoring.
4. Manifold:
   a. Manifolds shall be suited for gas purities up to 99.999 percent and be cleaned for oxygen service. Manifolds shall be manufactured from high purity brass or stainless steel barstock material.
   b. Manifolds shall be rated for inlet pressures up to 3000 psig and be able to deliver gas in range of 0-125 psig to piping system.
   c. Manifold controls shall include two bank regulators and explosion-proof pressure differential switches. Controls shall include line pressure regulator and gauge, cylinder pressure gauges, safety relief valve with NPT fitting for attaching to vent line and pressure switch activated alarm switch. Relief valve capacity shall exceed maximum regulator flow capacity and shall have set pressure higher than line it protects to prevent unnecessary depletion of cylinder in event of regulator malfunction. Relief valve shall vent into cabinet interior.
   d. Manifold shall be equipped with purge valves for primary cylinder. Purge gas shall be supplied by separate purge cylinder located in cabinet. Purge cylinder shall be provided with two-stage regulator with gauges and safety relief valve. Relief valve shall vent into cabinet interiors. Purge/evacuation cycle shall be automatically controlled by cabinet PLC.
   e. Manifold shall have excess flow valve located on supply from cabinet. Excess flow valve shall be provided with alarm reporting to cabinet PLC.
   f. Manifold shall be provided with emergency stop valve to be actuated from remote input.
   g. Entire assembly shall be helium leak tested to 10^5 sccs outboard with mass spectrometer and dead-end pressure tested for 24 h for creep.

D. Flammable Gas Cylinder Cabinet
1. Acceptable Manufacturers: AGA/Linde, Matheson, Linde Electronics and Specialty Gases or approved equal
2. Flammable gas cylinder cabinet shall accommodate one primary, one reserve, and one purge gas cylinder in single exhausted cabinet.
3. Cabinet:
   a. Painted steel cabinet with integral exhaust connection.
   b. Cabinet doors shall have fire-rated vision glass and louvers for air flow from surrounding space. Cabinet doors shall be self-closing and gasketed with locking latches.
   c. Cabinet interior shall include Unistrut mounting rails and cylinder clamps with tie down straps.
   d. Cabinet shall be provided with automatic sprinkler head rated at 155ºF.
   e. Cabinet shall have PLC controller for all critical process functions. Controller shall have

spare inputs and outputs for remote alarm monitoring.

4. Changeover Manifold:
   a. Changeover from primary to reserve supply shall take place automatically when primary supply becomes depleted. When depleted cylinder is replenished, actuation of clearly marked, easily operable lever on each regulator shall cause replenished bank to become reserve supply without requiring opening or closing of multiple bypass valves. Repositioning of operating levers shall expose indicator labels that clearly show if manifold has been properly reset and which cylinder is primary and which is reserve supply.
   b. Manifolds shall be suited for gas purities up to 99.999 percent and be cleaned for oxygen service. Manifolds shall be manufactured from high purity brass or stainless steel barstock material.
   c. Manifolds shall be rated for inlet pressures up to 3000 psig and be able to deliver gas in range of 0-125 psig to piping system.
   d. Manifold controls shall include two bank regulators and explosion-proof pressure differential switches to prevent drawing from reserve supply before primary supply is depleted. Controls shall include line pressure regulator and gauge, cylinder pressure gauges, safety relief valve with NPT fitting for attaching to vent line and pressure switch activated alarm switch. Relief valve capacity shall exceed maximum regulator flow capacity and shall have set pressure higher than line it protects to prevent unnecessary depletion of either or both cylinders in event of regulator malfunction. Relief valve shall vent into cabinet interior. Manifold shall be provided with flame arrestor on supplies from each cylinder.
   e. Manifold shall be equipped with purge valves for primary and reserve cylinders. Purge gas shall be supplied by separate purge cylinder located in cabinet. Purge cylinder shall be provided with two-stage regulator with gauges and safety relief valve with. Relief valve shall vent into cabinet interior. Purge/evacuation cycle shall be automatically controlled by cabinet PLC.
   f. Manifold shall have excess flow valve located on supply from cabinet. Excess flow valve shall be provided with alarm reporting to cabinet PLC.
   g. Manifold shall be provided with emergency stop valve to be actuated from remote input.
   h. Entire assembly shall be helium leak tested to 10^{-5} sccs outboard with mass spectrometer and dead-end pressure tested for 24 h for creep.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Nitrogen and Carbon Dioxide Piping: Gaseous nitrogen and carbon dioxide piping shall be installed according to requirements of CGA pamphlets and as shown on drawings.

B. Piping shall be installed above ground in buildings. Protect pipe openings during construction to prevent introduction of dirt and debris.

C. Shutoff valves shall be accessible in case of emergency; installed minimum of 5 ft from each piece of equipment.

D. Identify gas services during installation so that the chance for crossover of one gas service to a different terminal unit is avoided. Do not depend on test procedure listed herein to identify cross connections.

E. Manifold relief valves shall be piped to exterior or other appropriate points. Avoid discharging close to windows, doors and air intake louvers.

F. Changes in direction shall be made by use of fittings. No pipe bending allowed. Pipe size reductions shall be by use of reducing fittings, no bushings allowed.

3.2 UNDERGROUND WARNING TAPE

A. Provide warning tape for exterior buried compressed gas lines per Section 20 0553.

3.3 COPPER TUBING

A. Copper tubing shall be installed per Copper Development Association guidelines in addition to methods specified herein.

B. Brazed Copper Joints:
   1. Brazed joints shall be ASTM Grade 4 or 5 and have melting point of approximately 1250ºF. Solder impurities shall not exceed 0.15%.
   2. Tubing shall be delivered to site with original mill caps in place.
   3. Cut tube square, remove burrs from exterior of tube and ream interior of tube before assembly.
   4. Joints shall be cleaned and polished before brazing.
   5. Flux of any type shall not be used.
   6. Apply heat carefully to prevent damage to pipe, fittings and valves. Disassemble valves where possible to prevent damage to seats during brazing.
   7. Purge tube with nitrogen during brazing procedure. Provide manual shut-off valve and check valve as required for purge gas.

3.4 CLEANING

A. Piping and components that are provided "Cleaned for Oxygen Service" shall not require cleaning. Flush system with source gas until 100% concentration of service gas is verified at all outlets.

B. For components not provided "Cleaned for Oxygen Service" and components where cleanliness has been compromised, pipe and fittings shall be thoroughly cleansed of oil, grease, dirt or other contaminating materials by washing in a hot solution of sodium carbonate or trisodium phosphate mixing in proportions of 1 pound to 3 gallons of water. Scrubbing shall be employed where necessary to obtain complete cleaning. After washing, materials shall be rinsed thoroughly with clean hot water and dried with dry nitrogen. After cleaning, tubing, fittings, and valves shall be plugged or wrapped until item is to be installed. Particular care must be exercised in handling and in conditions of tools used to prevent oil and grease being introduced. If contamination has occurred, affected items must be rewashed.

C. Before actuation of gas supply, systems shall be flushed with dry nitrogen to ensure a clean system free of oil and construction debris. Nitrogen shall then be purged by source gas until 100% concentration of source gas is verified at all gas outlets for that service gas.

3.5 TESTING

A. Refer to testing paragraph of Section 20 00 00 - General Mechanical Requirements.

B. Pressurize piping system prior to connection of laboratory fixtures and check for leakage by examining each joint by means of Oxweld No. 23 Leak Test Solution or other non-frothing solutions approved for this purpose.
   1. Gaseous carbon dioxide piping shall be pressurized with dry nitrogen at 150 psi.
   2. Gaseous nitrogen system shall be pressurized with dry nitrogen at **[**150 psig**] [**300 psig**]**.
      a. Special gas piping systems shall be pressurized with oil free compressed air or dry nitrogen at 150 psig.

C. Test pressure shall remain in piping for at least **[2] [8] [24]** h. Source pressure shall be shut off and pipe temperature at beginning and end of test shall be recorded. Pressure changes, other than that caused by temperature change, will not be permitted.

D. Provide final pressure test at 100 psig for 8 h after connection of laboratory fixtures.

E. Test operation of pressure switches and verify that signals are properly transmitted.

3.6 HIGH PURITY GAS QUALITY CERTIFICATION

A. Particulate Testing
   1. Establish background count by connecting particle counter to 0.1-micron filter and record number of counts per volume. Background counting shall begin at least 8 h prior to final particulate analysis.
   2. Test system by withdrawing sample from **[25% of outlets] [each terminal point]** in system. Samples shall be taken by connecting particle counter to system using VCR type face seal fitting. Sample gas flow shall be sufficient to produce and maintain turbulent flow, i.e., maintain a Reynolds number greater than 4000.
   3. Duration of test at each terminal point shall be such that 10 scf of gas or 10 minutes of time elapses, whichever is greater. Test shall be considered failed if sampled gas does not fall within limits within 30 scf of gas or 30 minutes, whichever is greater.
      a. Failed lines shall be purged and testing defined herein shall be repeated until acceptable results are obtained.
   4. Acceptable particle test results:
      a. 0.01 micron <50 per 1 scf
      b. 0.1 micron <10 per 1 scf
      c. 0.2 micron <5 per 1 scf
      d. 0.3 micron and larger 0

B. Gas Purity Testing
   1. Gas purity testing shall be performed to detect residual moisture, oxygen, and total hydrocarbon content. Test shall be done with nitrogen filtered to 0.01 microns. Source gas shall be certified by supplier as having no impurities in excess of 5 ppm moisture and 1 ppm oxygen and hydrocarbon content. Purge gas source shall be tested prior to use as trace gas.
   2. Nitrogen shall flow continuously during sample period at no greater than 10 scfh to eliminate dilution of sample contamination.
   3. System shall be certified as acceptable if change increase from source gas to sample point of each impurity does not exceed following levels:
      a. Oxygen <1 ppm
      b. Moisture <2 ppm
      c. Total hydrocarbon content <1 ppm
   4. Duration of test at each test point shall be such that 10 scf of nitrogen or 10 minutes time elapses, whichever is greater. Test shall be considered failed if sample does not fall within limits within 30 scf of nitrogen or 30 minutes, whichever is greater.
      a. Failed lines shall be purged and testing defined herein shall be repeated until acceptable results are obtained.
   5. Test analyzer shall be calibrated prior to use. Certification of calibration shall be provided to Owner and copy to be retained with analyzer at all times.
   6. Test shall be performed on **[25% of outlets] [each terminal outlet]**.

END OF SECTION 22 63 14

SECTION 22 66 53 - CORROSION RESISTANT WASTE AND VENT SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section specifies pipe, fittings, equipment and methods for laboratory waste and vent piping system installed to 5 ft outside the building wall.

1.2 RELATED WORK

A. Section 20 05 20 - Excavation and Backfill

B. Section 20 05 29 - Piping and Equipment Supporting Devices

C. Section 22 11 14 - Exterior Services

D. Section 22 21 14 - Material Specialties

1.3 SUBMITTALS

A. Shop drawings on items specified herein.

B. Submit Manufacturer's technical data for the following:
   1. Pipe and fittings
   2. Joints
   3. Floor drains
   4. Cleanouts
   5. Sampling Port

PART 2 - PRODUCTS

2.1 MATERIALS

A. Use new materials unless otherwise noted.

2.2 PIPE

A. Underground:
   1. Schedule 40 chlorinated polyvinyl chloride pipe (CPVC), ASTM D1784, with solvent cement joints
      a. Manufacturers: Charlotte “ChemDrain”, Spears “LabWaste” or approved equal.

B. Above Ground:
   1. Schedule 40 chlorinated polyvinyl chloride pipe (CPVC), ASTM D1784, with solvent cement joints
   2. Provide 3M™ Fire Barrier Plenum Wrap 5A+ for piping above ceiling areas unless the piping material is rated to comply with ASTM E84 / UL 723 to have a flame spread of less than 25 and smoke developed index of less than 50 for use in plenum ceilings.

2.3 ADAPTERS

A. Provide where indicated and as necessary; glass to plastic compression coupling, plastic to metal mechanical joint, or glass to metal mechanical joint and/or compression coupling.

2.4 CLEANOUTS

A. Corrosion resistant materials similar to piping materials. Refer to Cleanout Schedule on drawings.

2.5 FLOOR DRAINS

A. Refer to Drain and Cleanout Schedule.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install piping neat and orderly; accomplish changes of direction using proper pipe fittings. Connect to sinks, cup sinks, floor drains, and other devices as shown on drawings. Conceal piping unless noted to be exposed in reagent rack. Piping within casework shall be coordinated with casework supplier.

B. Pitch vent piping to waste line. Install horizontal waste piping with minimum pitch of 1″ in 4 ft; except piping 3″ and larger may pitch 1″ in 8 ft. Make changes in direction of flow by use of drainage pattern fittings.

C. Set floor drains level and at low points. Protect weep holes from filling with concrete. Clamp safing to drain body for proper drainage.

D. Install cleanouts as shown on drawings. Locate cleanout access cover so that snake of100 ft can be properly used.

E. Provide caps and plugs on open pipe ends during construction phase to prevent construction debris from entering pipe.

F. Provide necessary transition fitting and couplings required when changing from one piping material to dissimilar material.

3.2 PLASTIC PIPING

A. Install plastic pipe and fittings as recommended by respective manufacturer. Fuse plastic pipe joints with surrounding temperature above freezing using equipment supplied by pipe manufacturer. Adhere to instructions for fusing as published by manufacturer. Instructions for fusing shall be kept on site.

B. Install mechanical joints in accordance with instructions from pipe/fitting manufacturer. Use materials of same manufacturer, especially made for mechanical jointing. Use pipe and fittings with factory cut groove, except pipe may be grooved in field using equipment and methods as recommended by manufacturer of pipe. Use hangers on each side of mechanical couplings.

C. Manufacturer's representative shall instruct workmen in proper installation techniques required for CPVC piping and fire wrap and provide certification to University's Representative that instruction has been given and proficiency demonstrated by Contractor in execution of installation of piping system.

D. Refer to HVAC drawings to determine plenum spaces.

E. Do not use plastic pipe when high temperature (above 100°F) water (at autoclaves, sterilizers, glasswashers, and similar devices) is discharged to receptor or drain. Provide minimum of 25 ft of PVDF or stainless-steel piping material downstream of high temperature drain discharge point.

3.3 TESTING

A. Refer to Testing paragraph of Section 20 00 00 - General Mechanical Requirements.

B. Water test may be applied to system either in its entirety or in sections. Piping shall be tightly plugged and submitted to 10 ft head of water located at highest point. Provide separate standpipe above highest point being tested or extend system to obtain required 10 ft head of water. Head shall be maintained for at least 30 minutes before inspection starts.

C. Defective work or material shall be replaced or repaired as necessary and inspection and test repeated. Repairs shall be made with new materials. No caulking of threaded joints or holes will be allowed.

D. Do not backfill pipe until successfully tested.

E. Testing with air will not be allowed.

3.4 CLEANING

A. After successful pressure test, clean and flush piping system to eliminate debris in drainage system.

END OF SECTION 22 66 53

SECTION 22 67 14.13 - PLASTIC PIPING FOR HIGH PURITY SERVICE

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section covers requirements for procurement, installation, inspection, and sanitization of SDR 11 CPVC piping, fittings, valves, and specialties for High Purity Water (HPW) service.

B. HPW system is defined by:
   1. This document
   2. P&IDs Flow diagrams
   3. Sections under Related Work below

1.2 RELATED WORK

A. Section 20 05 29 - Piping and Equipment Supporting Devices

B. Section 20 05 73 - Mechanical Systems Firestopping

C. Section 22 67 20.13 - High Purity Water System Equipment

1.3 SCOPE OF WORK

A. Contractor shall be responsible for procurement, installation, inspection, and sanitization of piping system.

B. Contractor shall provide personnel trained and experienced in installation of selected manufacturer's piping system. If personnel are not experienced at start of installation, piping manufacturer's representative shall train Contractor prior to installation. Training certification and experience record is required.

C. Contractor shall submit documentation on components proposed for system and shall obtain approval prior to purchase or fabrication of those components.

D. Contractor shall inspect system and provide documentation to demonstrate that system is installed according to Specification, is leak free, and has been sanitized according to procedure.

1.4 BASIS OF DESIGN

A. Service: HPW water
   1. Process Fluids: Water with resistivity of XX megohm
   2. Operating Pressure/Temp. 100 psig at 80°F
   3. Piping System
      a. Design Pressure: 150 psig at 100°F for components
      b. Material: SDR 11 CVPC as specified below.
         1) Joining method: Solvent cement
         2) Provide 3M Fire Barrier Plenum Wrap 5A+ for all above ceiling piping to comply with ASTM E84
         3) In lieu of providing Fire Barrier Plenum Wrap 5A+ for all above ceiling piping, provide pipe that complies with ASTM E84 (plenum rated piping)

1.5 SUBMITTALS

A. The following items must be submitted for review, and approved prior to purchase of item:
   1. Detailed descriptions of pipe, fittings, valves, and other components.
   2. Identification of joining method and fusion equipment.
   3. Detailed Sanitization Procedure (see Part 3.1).

4. Training certification for installation personnel.
5. Isometric drawings of piping from RO unit through distribution equipment.

B. The following documentation is required to be delivered with system:
1. Pressure Test Report
2. Sanitization Records
3. Manufacturer's material certifications
4. Record of fusion machine operating parameters for every joint
5. Joint inspection records

1.6 DELIVERY

A. Pipe, fitting, and components shall be furnished with plastic end-caps/plugs to prevent contamination and damage.

B. Pipe, fitting, and components shall be furnished in individually sealed bags to prevent contamination.

C. Pipe, fittings, and components shall be handled and shipped so as to protect from contamination and damage.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Spears EverTUFF CTS, Georg Fischer or approved equal.

2.2 GENERAL

A. Piping, fittings, and valves that are to be heat fused shall be products of same manufacturer.

B. Piping, fittings, valves, gaskets and accessories shall be compatible with Design Conditions in Part 1.5 as stated above.

C. Dimensions of end connections for valves shall be compatible with pipe and fittings.

D. Materials in contact with water shall be FDA approved for sanitary product contact surfaces.

2.3 PIPE, FITTINGS, & JOINTS

A. Low Extractable Schedule 40 PVC pipe and fitting for use on High Purity Piping per ASTM D1784, ASTM D1785, ASTM D2564. Pipe shall be sterilized and capped immediately after production. Provide 3M™ Fire Barrier Plenum Wrap 5A+ for piping above ceiling areas unless the piping material is rated to comply with ASTM E84 / UL 723 to have a flame spread of less than 25 and smoke developed index of less than 50 for use in plenum ceilings.

2.4 VALVES

A. General
1. Valve type shall be as indicated on flow diagram.
2. Valves shall be same material and manufacturer as piping.
3. Valves shall conform to Basis of Design in Part 1.5 above.
4. End Connections shall be spigot ends for SIB or BCF fusion; Non-contact infrared butt fusion; socket fusion or, if indicated on P&IDs Tri-Clamp or flanged ends.

B. CPVC Valves
1. Diaphragm Valves
a. Weir type, self-draining, PTFE diaphragm backed by EPDM, non-rising stem, position indicator, stroke limit stops.

b. Size 2" and smaller: Georg Fischer Type 515 or approved equal.
c. Size 2-1/2" and larger: Georg Fischer Type 317 or approved equal.

2. Ball Valves
   a. True union type, full port, Viton seals, Teflon seats.
   b. Georg Fischer Type 546 or approved equal.
3. Sampling valves
   a. Needle valve for sampling, Teflon seals.
4. Self-Contained Pressure Regulating Valves
   a. PTFE, EPDM backed diaphragm and Viton O-rings
   b. Sizing is per Section 22 6720.13.
5. Check Valves
   a. Ball check valves, Viton seals, CPVC ball

2.5 SPECIALTY ITEMS

A. Flexible Sections
   1. Flexible sections indicated on drawings shall be smooth FDA Approved Teflon with external polypropylene reinforcing braiding and tri-clamp connections. Teflon inner core is extended through flange and flared to form gasket. Backing flange to be PVDF with 150 # ANSI dimensions. Flexible sections shall be rated for at least 150 psig.

B. Faucet Connections
   1. Tubing for connection to lab faucets shall be polypropylene, or PFA tubing, 3/8" OD; 0.062" wall, rated to at least 150 psig at 80°F. Polypropylene tubing shall be made from virgin copolymer conforming to FDA requirements for food contact.

2.6 INSTRUMENTATION

A. Instrumentation Specifications are covered in Section 22 67 20.13.

PART 3 - EXECUTION

3.1 GENERAL

A. Install and inspect piping and accessories as per Contract Documents and recommendations of equipment manufacturers.

B. Provide installation personnel who are trained and experienced with assembly of selected piping in high purity systems.

C. Provide installation personnel who are certified by piping manufacturer for specified joining method.

D. Provide diaphragm valves or type of valves as indicated on drawings.
   1. Inspect delivered components to verify conformance to specification and to check for evidence of damage or contamination. Do not use suspect materials.

E. Maintain high level of cleanliness during handling and installation.
   1. Prior to starting work, identify areas that will be used for storage and fabrication, and take measures to prevent contamination from adjoining areas.
   2. Handle and store tubing, fitting, and components in a manner that prevents impact damage, excessive stress, and contamination.
   3. Maintain manufacturer's protective packaging in place until immediately prior to use.
   4. Keep openings on assemblies sealed during fabrication to prevent contamination prior to final installation.

F. Install piping using minimum number of joints.

G. Monitor and inspect installation process to ensure:
   1. Conformance with this Specification.
   2. Compliance with manufacturer's requirements.
   3. Piping is supported as specified.

3.2 INSTALLATION

A. CPVC Joint Fabrication
   1. Perform joining in strict accordance with manufacturer's recommended procedures. Cut piping in strict accordance with manufacturer's recommended procedures.
   2. Clean components prior to fusion conscientiously and in strict compliance with Manufacturer's recommendations for high purity services.
   3. Form joints by solvent welding in accordance with appropriate parts of ASTM D-2855, using solvent cement conforming to ASTM F-493 and to NSF International for use on potable water systems.
   4. Use union joints only where indicated on drawings or where necessary to connect to accessories and equipment. Verify that O-ring is correctly indexed prior to tightening. Tighten hand tight only; do not use tools. Tighten flanged connections in strict accordance with manufacturer's recommendations.
   5. Use threaded connections only if no other option for connecting to equipment.

B. Configuration
   1. Horizontal runs shall be continuously supported by approved equal leg aluminum, stainless steel, or galvanized steel "V" channel under pipe. Support tubing in strict accordance with manufacturer's recommendations for a maximum deflection of 0.01" per foot at operating temperature stated in part 1.5 above or 86°F, whichever is higher. In additional to these supports, supports shall be provided at all changes of direction.
   2. Install tubing so that there are no undrainable pockets. Slope tubing minimum of one percent towards use points or low point drains so that 100% of the water in system will drain freely.
   3. Provide adequate support of pipe at pump discharge.
   4. Orient diaphragm valves per manufacturer's instructions to ensure complete drainage.
   5. Install check valves and orifice plates in vertical sections. If installation in horizontal is required, provide eccentric valve or plate and orientate properly.
   6. Provide low point drains and high point vents in compliance with drawings and Engineering review of isometric drawings.
   7. Rough or sharp edges must not be in contact with pipe.
   8. Erect tubing without spring or force. Connect to equipment such that stress is not transferred to equipment.
   9. Install all tee connections so as to minimize dead leg. Distance from sealing point on branch to inside of main line wall shall be less than four branch line diameters.
   10. Route lines so as to accommodate thermal expansion where required. Provide supports appropriate for thermal expansion. Install supports so that movement of piping due to thermal expansion is not impeded.

C. In-Line Devices
   1. Locate and orient in-line specialty items and instrumentation so as to allow for access after insulation is installed, including:
      a. Access for maintenance and calibration.
      b. Viewing of gauges by operating personnel.

c. Clearance for removal of regularly replaced components (filter elements, UV lamps, etc.)
d. Convenient operator access to sample valves and insertion of sampling container.

2. Install in-line specialty items and instruments such that they are free draining.
   a. Install restriction orifices in vertical section of pipe unless. If orifice must be in horizontal run, use an orifice that is eccentric drilled and orientate with hole at low point.
   b. Install in-line specialty items and instruments in strict accordance with manufacturer's instructions.
   c. Install sensors for conductivity and resistivity in run of a horizontal tee with flow exiting upward branch.
   d. Provide length of straight pipe upstream and downstream of flowmeters. As specified by manufacturer.
   e. Install pressure regulators and backpressure regulators with at least 10 pipe diameters of straight pipe upstream and downstream of regulator.
   f. Install sanitary orifice plates in sanitary unions or in Tri-Clamp joints as indicated on drawings. Clearly tag orifice location.
   g. Securely support relief valves and relief discharge lines.

D. Penetrations
1. Floor
   a. Provide sleeves on piping penetrations through floor slabs one pipe size larger than service piping and extend sleeve 2" above finished floor.
2. Fire-Rated walls:
   a. Provide firestopping per Section 20 0700 - Mechanical Systems Firestopping.

3.3 USE POINT CONNECTIONS

A. Faucets
1. Install zero-static tee diaphragm valve with 1/2" outlet port in loop line
2. Connect outlet of valve to faucet with 3/8" polypropylene or PFA tubing.
3. Use shortest length of tubing as possible.

B. Equipment
1. Install zero-static tee diaphragm valve on distribution line with outlet size indicated on distribution drawing
2. Install piping per size from valve to equipment.
3. Install Restriction Orifice if indicated on drawing.
   a. Use concentric plate in vertical lines.
   b. Use eccentric plate in horizontal lines.

3.4 TESTING

A. Inspection
1. Visually inspect all joints and verify that they comply with manufacturer's criteria for a properly formed joint.
2. For joints fused by machines that generate labels, verify that each joint has label.
3. Check diaphragm valve bonnet bolts for correct torque.

B. Hydrotest
1. Execute all pressure testing safely.
   a. Do not pressurize plastic piping with gas.
   b. Isolate equipment or instrumentation that cannot to be exposed to test pressure.
   c. Notify personnel with access to system that testing is to take place. Tag each use point to indicate that valve is not to be used.
   d. Ensure that air is completely vented from system to avoid a hazardous condition.

e. Pressurize system gradually.
f. Provide controls to prevent pressure from exceeding specified test pressure.

2. Ensure that cleanliness of system is not compromised.
   a. Provide water for testing and flushing that has quality approved equal to or better then service water.
   b. When performing preliminary testing of sections of system, after test is complete flush all water out of system and ensure that it drains completely. Close all openings in system after draining.
3. Execute final acceptance test on completed piping system.
   a. Do not insulate or conceal piping until testing is complete.
   b. Test system in sections or as a whole, but all joints need to be covered in test.
   c. Ensure that air is completely vented from system.
   d. Pressurize gradually and hold system at 100 psig for 4 hours. An initial pressure decrease will occur due to pipe elongation after pressurization. After 4 hours, pressure loss will stabilize, and pressure must then hold at test pressure without a loss of 1% over period of one hour to pass test.
   e. Monitor pressure with gauge located near bottom of system that is readable to at least plus or minus 1 psi.
   f. Note if pressure drops more than 1% over test period and determine source of leakage.
      1) Cut out and reinstall defective joints.
      2) Hand tighten wing nuts on sanitary clamps if required. If leakage continues, install new gasket. Do not tighten using tools.
      3) Retest.
4. Provide written certification that includes identification of portion of system tested, date, time, test criteria, test medium and pressure, duration, and name and title of person responsible for test.

3.5 SANITIZING/FLUSHING

A. General
   1. Perform sanitization after inspection, documentation, and acceptance of system. If chemical sanitation is not required then this procedure will be used for flushing, without addition of sanitant.
   2. Prior to sanitization, slowly fill system with water while venting air from system. Continue to check that all air has been vented after water is recirculating.
   3. Adjust any pressure regulators to their preliminary setpoints.
   4. Perform sanitization immediately prior to placing system in operation and coordinate with University's representative.
   5. Safety:
      a. Follow manufacturer's safety recommendations for handling of chemicals.
      b. Disconnect power to UV lights prior to sanitization.
      c. Provide controls to ensure that system remains within pre-established sanitization conditions and that system pressure does not exceed Design Conditions in Part 1.5 above.
      d. Ensure that proper chemicals are used and that they are handled safely.
      e. Notify personnel with access to system that sanitation is being performed. Prior to cleaning, tag each use point to indicate that valve is not to be used.
   6. Provide all equipment, fittings, and supplies necessary to execute sanitization.
   7. Prepare a procedure which identifies:
      a. Recirculation circuits and sampling points.

b. Measures required to confine sanitizing solution.
c. Step-by-step procedure (including any modifications to piping or controls).
d. Sign-off matrix.

8. Isolate equipment or instrumentation that is not to be exposed to sanitant.
   a. Bypass ion exchange beds.
   b. Turn off UV lights.
   c. Record all changes made to system that are required to execute test.
9. Record execution of procedure including University's Representative sign-off.
10. Sanitization may be performed with either hydrogen peroxide or Peracetic acid.

B. Procedure for hydrogen peroxide
1. Makeup solution of 5% hydrogen peroxide with water. Water shall be equivalent to service water quality or deionized water (minimum 1 megohm) that has passed through a 1.0-micron filter.
2. Fill entire system with solution. All gas must be vented, and system set up for recirculation so that all parts will be exposed to solution.
3. Recirculate at flow rate of at least 3 fps. Draw samples at points of use and at other key sample points to confirm presence and concentration of peroxide.
4. Confirm that there is solution throughout system, and then continue to recirculate for at least 4 h. Draw off water for at least one minute at each use point.
5. After recirculation with solution flush system with product quality water for at least 45 minutes, rotating draw off from all use points.
6. Test water with solution residual test strips at key sample points to ensure less than 1 ppm is achieved.
7. Continue to flush for 30 minutes. Draw off water for at least 1 minute at each use point.
8. Return system to its original configuration. Verify that all modifications that were made to piping or controls were restored. Prepare system for normal operation.

C. Procedure for peracetic acid, Minncare or approved equal.
1. Makeup solution of 1% Minncare with water that is less than 70°F. Water shall be equivalent to service water quality or deionized water (minimum 1 megohm) that has passed through a 1.0-micron filter. Fill entire system with solution. All gas must be vented, and system set up for recirculation so that all parts will be exposed to solution.
2. Recirculate at flow rate of at least 3 fps. Draw samples at points of use and at other key sample points to confirm presence and concentration of peracetic acid solution using test strips. Monitor system temperature to ensure that is does not rise above 75°F.
3. Confirm that there is solution throughout system, and then continue to recirculate for at least 3 h. Draw off water for at least one minute at each use point.
4. After recirculation with peracetic acid solution flush system with product quality water for at least 45 minutes, rotating draw off from all use points.
5. Test water with peracetic acid solution residual test strips at key sample points to ensure less than 1 ppm is achieved.
6. Continue to flush for 30 minutes. Draw off water for at least 1 minute at each use point.
7. Return system to its original configuration. Verify that all modifications that were made to piping or controls were restored. Prepare system for normal operation.

END OF SECTION 22 67 14.13

SECTION 22 67 20.13 - HIGH PURITY WATER SYSTEM

<NOTE TO REVIEWER: ALL COLORED AND BRACKETED TEXT SHOULD BE REVIEWED, EDITED, AND CONVERTED TO BLACK TEXT PRIOR TO PUBLICATION OF THESE SPECIFICATIONS>

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section specifies the system for production of High Purity Water (HPW).

B. Complete specification of the system is defined by:
   1. This Section
   2. Sections listed under Related Work below.
   3. P&ID and Flow Diagrams on drawings.
   4. Equipment layout on drawing.

1.2 SCOPE

A. Contractor's Scope of Work includes:
   1. Subcontracting with an acceptable water treatment equipment vendor (Vendor) and managing Vendor's scope of work and performance. Coordinating:
      a. Size of equipment and skids with delivery schedule to ensure that equipment can be moved into place.
      b. A drawing showing layout of equipment positioned in Owner's area.
      c. Identification of all field installation of piping and wiring interconnections required between Vendor's equipment.
   2. Installation of Vendor's equipment and providing utilities to equipment.
      a. Providing piping and wiring interconnections between Vendor equipment as required.
   3. Providing distribution piping.
   4. Coordination of startup and system turnover with Owner's Representative to ensure system is always actively managed.

B. Vendor's Scope of Work includes furnishing:
   1. A complete system, as defined in this document.
   2. Detailed drawings and instructions to Contractor for installation for field piping and wiring interconnections required between Vendor's equipment and components.
   3. Documentation
   4. Sanitization of system
   5. On-site support checkout, startup, and testing
   6. Demonstration that system meets quality and operational requirements
   7. On-site training
   8. Operation of system until turnover to Owner Representative (1 year after project substantial completion).

1.3 RELATED WORK

A. HPW system shall meet requirements of following Sections:
   1. Section 20 05 13 - Motors
   2. Section 20 05 14 - Variable Frequency Drive (VFD) System
   3. Section 22 67 14.13 - Plastic Piping for High Purity Service

1.4 BASIS OF DESIGN

A. Vendor is responsible for providing system that consistently and reliably delivers water of the

following quality to the supply of distribution loop piping.

1. If Vendor believes that system design specified herein will not meet the quality standards, Vendor shall notify Owner's Representative.

B. Water Quality Requirements

1. System shall provide water meeting NCCLS/CAP Type III reagent water specification to points of use. Specification is:
   a. Resistivity: ≥ 0.10 megohm - cm at 25°C
   b. Silica: ≤ 1.0 mg/l SiO_2
   c. Microbial: none

C. Supply Water Quality (Based on 2016 Water Quality Report County of SLO CSA10 and 10A – Cayucos System Number 4010025 and 4010901)

1. Vendor is responsibility for confirming validity of supply water analysis and notifying Representative if quality is significantly different than stated below.
2. Minimum temperature of supply water: 80°F
3. Minimum pressure of supply water: **[XXX]** psig
4. Maximum pressure of supply water: **[XXX]** psig
5. Water production system shall be designed to produce required water quality based on maximum values from following water supply analysis.

Water Source: County of San Luis Obispo - Variable Source Analysis				
Constituent	Average		Maximum	
Residual Chlorine, Total	106	ppm	1.28	ppm
Total Alkalinity	223	ppm	223	ppm
Total Hardness	321	ppm	321	ppm
Total Dissolved Solids (TDS)	440	ppm	440	ppm
Specific Conductance	755	µS/cm	755	µS/cm
Turbidity	0.13	NTU's	0.58	NTU's
Magnesium	53	ppm	53	ppm
Sodium	48	mg/L	48	mg/L
Nitrogen (Nitrate)	0.25	ppm	0.50	ppm
Sulfate (SO4)	97.2	ppm	97.2	ppm
Trihalomethanes	49.9	ppb	79.7	ppb

D. Capacity Requirements

1. System shall produce **[XXX]** gpm of water of quality stated above.
2. Individual equipment shall comply with capacity and efficiency requirements stated below.

E. Size Requirements

1. Equipment shall be located in area shown on drawings referenced in Part 1.1. Location and sizes of equipment shown in those areas are preliminary.
2. Contractor shall work with Vendor to determine equipment layout and submit an accurate drawing indicating positions of equipment in the area.
3. Layout shall ensure:
   a. Selected equipment and skid sizes will be able to pass through available building opening and passageways, or must be delivered prior to completion of that area of building.
   b. Proper access to HPW equipment and instrumentation for operations and maintenance.
   c. Compatibility with floor drains shown on drawings.
   d. Clearance for removal of regularly replaced components (filter elements, UV lamps, etc.)
   e. Access to tank manway and components on top of tank.

F. Site Conditions
1. Seismic Zone: refer to structural documents
2. System location: mechanical room
3. Electrical classification: non-hazardous

1.5 DOCUMENTATION

A. The following documents shall be furnished as follows:

	Submit for Approval	Upon Delivery	Turn Over Package
Production flow rates; flows to drain	X		
Piping and Instrumentation Diagram (P&ID)	X	X	As built
Pump Curves with Operating Points	X		X
Utility Loads	X		X
Drawing of system in facility space	X		
Instructions for Rigging, Storage, and Anchoring		X	
Instructions for extended storage of system, if necessary		X	
Detailed Equipment drawings	X	X	X
Equipment List	X		X
Descriptions of equipment and components.	X		X
Instrument List	X		X
Instrument Cut sheets	X		X
I/O List	X	X	X
Calibration Certifications		X	X
Operational and control description and functions	X		
Functional Specification	X	X	As built
Loop Diagrams		X	X
Control Schematics		X	X
Control Panel wiring drawings		X	As built
Component Cut Sheets	X		X
PLC Program Printout and Disk File			As built
OIT Configuration		X	As built
Electrical single line diagrams	X	X	X
Schematic wiring diagrams		X	X
Electrical panel drawings		X	X
Sanitization Procedure	X	X	
Acceptance Test Procedures		X	
Acceptance Test Report			X
Water sampling results			X
O & M Manuals		X	As built
Training Program Outline		X	
Service Agreement Proposal		X	

1.6 WATER TREATMENT EQUIPMENT VENDORS

A. Acceptable Vendors: Water Works, Evoqua Water Technologies, Veolia, Puretech, WCC Water Control Corporation or approved equal

1.7 DELIVERY

A. Vendor shall provide complete instructions on handling, rigging, anchoring, and on-site reassembly with unit.

B. Vendor is responsible for packaging to ensure unit arrives undamaged and uncontaminated.
   1. Nozzles shall have covers which protect the face from damage and seal system from contamination.
   2. Parts shipped loose shall be boxed and properly identified with durable, waterproof shipping tags attached with stainless steel wire or plastic tie strips. Parts shall be match marked for easy reassembly at site.

1.8 WARRANTY

A. System components shall be warranted from defects in materials and workmanship by respective manufacturer for period of 1 year from date of acceptance of system by Owner.

PART 2 - PRODUCTS

2.1 GENERAL

A. For equipment that is skid mounted:
   1. Size of skid must be compatible with building dimensions and/or delivery must be coordinated with construction schedule to ensure that skid can be moved into building and set in place.
   2. Skid size and dimension must be compatible with room layout.
   3. Skids shall conform to AISC Manual of Steel Construction.
   4. Skid construction shall comply with local and state code seismic requirements.
   5. Single connection for each utility and for drain shall be provided.
   6. Frame to be stainless steel or carbon steel with 2 coats epoxy paint.
   7. Frame shall adequately support system components at their operating weights.
   8. Surfaces that allow water to pool on part of frame are not permitted.
   9. Skids shall be designed so that they may be lifted by both forklift truck and overhead crane.
   10. Vendor shall inform contractor of field work required to assemble and interconnect skids.

2.2 SUPPLY WATER BOOSTER PUMP

A. Two Booster Pump Units shall be provided.
   1. Each unit shall be a Grundfos EZ Boost system, with a 15BMQE 05A-110 pump, 2-gal tank, constant pressure controller kit (controller and sensor), and interconnection wiring.
      a. The two units shall be piped in parallel. One pump will be the installed spare. Switch over between units shall be a manual operation.

2.3 MULTI-MEDIA FILTER

A. Multi-media filter shall be a **[single] [duplex alternating]**, fiberglass vessel with internal distributors,

piping, fully automatic brass multi-port control valve, pressure gauges, sample valves and media. Unit shall be preassembled, prewired, and hydrostatically tested. Media shall be packaged separately.

B. Design Criteria
   1. Each vessel shall be capable of handling the service flow rate with the following criteria:
   2. Service flow: **[XXX]** gpm
   3. Sizing criteria: less than 3 gpm/ft^2 at design flow
   4. Backwash Flow Rate: gpm/ft^2
   5. Fast Rinse Flow Rate: 5-15 gpm/ft^2
   6. Suspended Solids Removal: 10-micron
   7. Clean Bed Pressure Drop: less than 5 psi at design flow rate
   8. Each filter in a duplex unit shall be capable of handling design flow at specified pressure drop.

C. Mechanical
   1. Tank shall be:
      a. Material: Fiberglass
      b. Pressure Rating/Test Pressure: 100/150 psig
      c. Temperature Rating: 120°F
      d. ASME Code Stamped: No
      e. Floor Support: Structural base
      f. Piping Connections: threaded
      g. Internal distributors shall be PVC or ABS.
         1) Inlet Distributor (Top): Top inlet baffle
         2) Underdrain Distributor (Bottom): Hub radial with laterals
      h. Access: in top head for control valve connection, media loading and removal.
   2. Media: 3 support layers and 3 active filtration layers. Active filtration layers shall be anthracite, sand and fine garnet (top to bottom). Support layers are medium garnet, medium gravel, and coarse gravel.
   3. Piping: Per referenced pipe section.

D. Controls: Backwash frequency controlled by seven-day time clock. Operator shall have option to select day-of-week and time-of-day for backwash to occur.

E. Electrical: 120 VAC, single phase, 60 Hz

F. Pressure gauges shall be provided before and after unit.

G. Sample valve shall be provided after unit.

2.4 CARTRIDGE FILTERS

A. Description: Cartridge filter housing with hydrophilic cartridges for water filtration.

B. Acceptable Manufacturers: Ametek, Pall, Millipore, Sartorius or approved equal

C. Design flow: **[XXX]** gpm for each filter housing

D. Filter rating: **[10 micron][XXX]**

E. Pressure Drop: **[**3 psi**] [XXX]** at design flow

F. Housing Pressure Rating: 125 psig

G. Pressure gauges shall be provided before and after unit.

H. Sample valve shall be provided after unit.

2.5 WATER SOFTENER

A. Unit shall be comprised of **[single] [duplex alternating,]** water softener tank**[s]**, complete with

piping, automatic brass control valves, controller, pressure gauges, sample valves, resin, gravel, outlet "Y" strainer, dry-brine tank and brine eductor. Unit shall be preassembled, prewired, and hydrostatically tested. Media shall be packaged separately.

B. Design Criteria
1. Each tank shall be sized to handle the service flow rate with the following criteria:
2. Service flow: **[XXX]** gpm
3. Volumetric Flow Rate: less than 3 gpm/ft^3 at service flow rate
4. Velocity: greater than 2.5 gpm/ft^2
5. Normal hardness leakage: Less than 1 ppm as $CaCO_3$
6. Endpoint effluent hardness: Less than 5ppm as $CaCO_3$
7. Back wash flow rate: 4 6 gpm/ft^2
8. Type: Resin Amberlite IR-120-Na (Rohm and Haas) or approved equal
9. Regenerant Chemical: saturated NaCl
10. Regenerant Quantity: 15 lb./ft^3 maximum
11. Regeneration Rate: 0.5 to 0.63 gpm/ft^2
12. Method of Chemical Introduction: Eductor
13. Capacity: 30,000 grams/ft^3 (as $CaCO_3$) at max salt dosage

C. Mechanical
1. Softener vessel
   a. Material: Fiberglass or epoxy coated carbon steel
   b. Pressure Rating/Test: 100/150 psig
   c. Temperature Rating: 120°F
   d. ASME Code Stamped: No
   e. Floor Support: Structural base
   f. Piping Connections: threaded
   g. Vessel internal distributors shall be PVC or ABS.
      1) Inlet Distributor (Top): Top inlet baffle
      2) Underdrain Distributor (Bottom): Hub radial with PVC laterals.
   h. Access ports shall be provided in top head for control valve connection, media loading and removal.
2. Piping: Per referenced pipe section.
3. Y-Strainer: Bronze or PVC body with 20 mesh screen

D. Brine Tank:
1. Description: Dry-brine system with elevated grid plate
2. Quantity: 1
3. Material: Polyethylene
4. Salt Dose: 6-15 lb./ft^3 of softener resin

E. Controls
1. Motor-driven control valve shall stage each softener through regeneration steps. Regeneration shall be initiated by signal from alternator controller.
2. Regeneration frequency shall be based on throughput volume, totalized at common effluent.

F. Electrical: 120VAC, 1 Ph, 60 Hz power supply

G. Pressure gauges shall be provided before and after unit.

H. Sample valve shall be provided after unit.

2.6 CARBON FILTER

A. Unit shall be comprised of a **[single][duplex alternating]** carbon filter**[s]**, complete with piping, fully automatic brass motor driven multi-port control valve, pressure gauges, sample valves and media.

Unit shall be preassembled, prewired, and hydrostatically tested. Media shall be packaged separately.

B. Design Criteria
1. Each bed shall be capable of handling the service flow rate with the following criteria:
2. Service flow: **[XXX]** gpm
3. Flow Rate Criteria: less than 7 gpm/ft^2 at design flow rate
4. Backwash Flow Rate: 10 gpm/ft^2
5. Fast Rinse Flow Rate: 5-10 gpm/ft^2
6. **[Chlorine Removal: 0.0** ppm **at carbon effluent]**
7. **[Chloramine Removal 0.0** ppm **at carbon effluent]**
8. Clean Bed Pressure Drop: less than 5 psig at design flow rate

C. Mechanical
1. Vessel
   a. Material: Fiberglass
   b. Pressure Rating/test: 100/150 psig
   c. Temperature Rating: 120°F
   d. ASME Code Stamped: No
   e. Internal distributors:
      1) Material: PVC or ABS
      2) Inlet Distributor (Top): Top inlet baffle
      3) Underdrain Distributor (Bottom): Hub radial with laterals
   f. Access: ports in top head for control valve connection and media loading/removal.
2. Media: Acid washed Activated Carbon, Fine Gravel, Medium Gravel.
3. Piping:
   a. As per referenced pipe Section.
   b. Provide connections for sanitization.

D. Controls: Backwash frequency controlled by seven-day time clock. Operator shall have option to select day-of-week and time-of-day for backwash to occur.

E. Electrical: 120 VAC, single phase, 60 Hz

F. Pressure gauges shall be provided before and after unit.

G. Sample valve shall be provided after unit.

2.7 CARBON FILTER – SERVICE EXCHANGABLE

A. Description: Service exchangeable activated carbon cylinder.

B. Design Flow: **[XXX]** gpm

C. Design Criteria
1. Flow Rate Criteria: less than 7 gpm/ft^2 at service flow
2. **[Chlorine Removal: 0.0** ppm **at carbon effluent]**
3. **[Chloramine Removal 0.0** ppm **at carbon effluent]**
4. Clean Bed Pressure Drop: less than 5 psig at service flow rate

D. Mechanical
1. Vessel:
   a. Material: Fiberglass
   b. Pressure rating/test: 100/150 psig
   c. Temperature rating: 120°F
   d. ASME Code Stamped: No
   e. Piping Connections: Threaded
2. Hoses: Polypropylene

3. Carbon: New virgin activated carbon

E. Pressure gauges to be provided before and after unit. Sample valve to be provided after unit.

2.8 CARTRIDGE FILTERS

A. Description: Cartridge filter housing with hydrophilic, cartridges for water filtration.

B. Acceptable Manufacturers: Ametek, Pall, Millipore, Sartorius or approved equal

C. Design

1. Filter F-**[XXX]**

a. Design flow: **[XXX]** gpm
b. Filter rating: **[XXX]** micron absolute
c. Pressure Drop: [3 psig] **[XXX]** at design flow

2. Filter F-**[XXX]**

a. Design flow: **[XXX]** gpm
b. Filter rating: **[XXX]** micron absolute
c. Pressure Drop: [3 psig] **[XXX]** at design flow

D. Mechanical:

1. Housing Material: **[Polypropylene] [316 stainless steel]**
2. Housing Pressure Rating: 125 psig
3. Gasket Type: **[EPDM] [Silicone]**
4. Connection Type: **[Flanged] [Threaded]**

E. Instrumentation

1. Pressure indicators to be provided before and after unit. Sample valve to be provided after unit.

2.9 REVERSE OSMOSIS (RO) UNIT

A. RO unit shall be skid mounted, fully automatic, single pass system. Unit shall be preassembled, prewired, and hydrostatically and functionally tested.

B. Design Conditions

1. Design flow: **[XXX]** gpm permeate
2. Feedwater Temp: **[XXX]**°F

C. Design Criteria

1. Max Average Permeate Flux/Element: 18 gfd (Gallons/ft^2/day)
2. System Recovery: **[50][75]**%
3. Minimum Salt Rejection: 96% at stated recovery
4. RO Membranes:

a. Type: Polyamide thin-film composite
b. Manufacturer: Filmtec (Dow) or approved equal
c. Minimum Salt Rejection: 98%

D. Instrumentation

1. The following instruments shall be provided:

a. Conductivity sensors on feed and permeate. TDS monitor is not permitted.
b. **[Low pressure switch][Pressure Indicating Transmitter]** on supply
c. **[Flow indicator][Flow Transmitter]** on permeate
d. **[Flow indicators on reject][Flow Transmitter]** on reject
e. [High pressure switch][pressure indicating transmitter] on feed to membranes

E. Mechanical

1. Frame:

a. System shall be supported by epoxy-coated frame, and designed to provide easy access for servicing, maintenance, and monitoring of operation.
b. Piping shall be neatly arranged and supported on frame.
c. Frame shall be designed for seismic zone indicated in Part 1.1 and shall offer maximum support and protection for system components.

2. RO Prefilter: 5-micron absolute, sized for max 3 psi pressure drop at maximum RO flow.
3. Valves:
   a. Automatic, pneumatically actuated, non-metallic, or stainless-steel valve shall be provided in feed line.
   b. High pressure valves, including pump discharge throttling valve, reject throttling needle valve and reject recycle throttling needle valve shall be 316 stainless steel.
   c. Actuated flush valve shall be provided on a by-pass around reject throttle valve.
   d. Sample valves shall be provided on feed, product, and reject lines. Individual sample valve on product tubing of each pressure vessel shall be provided for analyzing system performance.
   e. Reject and reject recycle needle valves shall be mounted in close proximity to their respective flow rate indicators for ease of field adjustment.
4. Pressure gauges shall be furnished to monitor RO inlet pressure, pump suction pressure, membrane feed pressure, membrane reject pressure and RO product pressure.
5. Pressure Vessels:
   a. Manufacturer: Advanced Structures, Inc. or approved equal
   b. Material: FRP
   c. Rating: 400 psig
6. Piping:
   a. Piping shall be designed for minimal removal during membrane loading.
   b. Nozzles shall be provided for connection of temporary lines for cleaning and sanitizing RO membranes and vessels.
7. Material and connections:
   a. Feed and Reject Pipe: Per referenced pipe section
   b. High Pressure Pipe: 316L stainless steel tubing
   c. Product Piping: Per referenced pipe section
   d. Pump: 316 stainless steel

F. Control System: Microprocessor or PLC based control system shall monitor and control operation of system and communicate with pretreatment equipment and distribution tank level as required. Skid mounted control panel shall house control system, operator interface controls, solenoids, IEC motor starter(s), step down transformer, high voltage disconnect. Control system shall be fully programmed and integrity tested at factory prior to shipment.
1. System shall provide the following functions
   a. On start-up, inlet valve should open prior to initiation of pump to completely fill the system with water.
   b. Upon shutdown of pump, actuated flush valve shall open for 3 minutes. After 3 minutes, flush valve and inlet valve shall close.
   c. Provide one discrete general fault signal for use.
2. Panel shall include:
   a. Lights, pushbuttons, and switches for status and control of system
   b. Conductivity monitor for feed and permeate
   c. Elapsed run time indicator
   d. Alarm horn
   e. System power switch

f. Nameplates for device identification

g. Automatic reject flush indicator and controls
3. Alarm conditions shall Include:
a. Low feed pressure
b. High and High High permeate conductivity
4. Unit Shutdowns include:
a. Low feed pressure
b. Pretreatment filters in backwash
c. Product storage tank full
d. High High permeate conductivity
5. Functional Specification
a. Complete functional specification shall be provided which describes:
1) operation of unit
2) control loops
3) interlocks
4) alarms
5) startup/shutdown sequences
6) security

G. Electrical
1. RO unit shall have a single connection for 480 V, 3 phase power. Transformers for devices requiring other voltage shall be provided integral to skid.

2.10 MIXED BED DI COLUMNS - EXCHANGABLE

A. Description: Service exchange, mixed resin, ion exchange beds. Beds contain 60% anion/40% cation resin mixture, premium grade **[capable of producing 18 megohm water]**.

B. F-**[XXX]**, CO-DI-**[XXX]**
1. Design flow: **[XXX]** gpm
2. Design Criteria
a. Volumetric Flow Rate: Less than **[**4 gpm/ft^3**]** **[**10 gpm/ft^3**]** at design flow
b. Pressure Drop: Less than **[**3 psi**]** **[**5 psi**]** **[XXX]** per bed at design flow
c. Cation Resin: Strong acid, hydrogen form
d. Anion Resin: Strong base type 1, hydroxyl form
e. Resin Capacity: 15,000 grains/ft^3
f. Sodium Leakage: 0.1 ppm

C. Vendor shall provide beds in configuration shown on flow diagram in sufficient number to achieve design flow and criteria.

D. Mechanical
1. Vessels: fiberglass reinforced plastic (FRP) with vinyl ester lining and connections
2. Vessel Rating: 150 psig at 100°F
3. Hoses: polypropylene
4. Piping: as per referenced pipe Section

E. Instrumentation
1. Locate conductivity indicator after first set of beds
a. Setpoint **[XXX]** megohm
2. Pressure gauges shall be provided before and after unit. Sample valve shall be provided after unit.

2.11 CARTRIDGE FILTERS - HIGH PURITY

A. Description: T-style cartridge filter housing with hydrophilic, membrane pharmaceutical grade

cartridges for water filtration

B. Acceptable Manufacturers: Pall, Millipore, Sartorius, or approved equal

C. Design Conditions
   1. Filter F-**[XXX]**
      a. Design flow: **[XXX]** gpm
      b. Filter rating: **[0.2 micron] [XXX]** absolute
      c. Pressure Drop: [2 psi] **[XXX]** at design flow
   2. Filter F-**[XXX]**
      a. Design flow: **[XXX]** gpm
      b. Filter rating: **[1 micron] [XXX]** absolute
      c. Pressure Drop: [2 psi] **[XXX]** at design flow

D. Mechanical:
   1. Housing Material: 316 stainless steel, 25 Ra
   2. Housing Pressure Rating: 145 psig
   3. Gasket Type: FDA approved Silicone
   4. Housing Configuration: T-style
   5. Connection Type: Tri-clamp
   6. Sample valves: Inlet and outlet
   7. [Drain valve: 1/2"**]**

2.12 ULTRAVIOLET LIGHTS

A. Description: In-line Ultraviolet Lights

B. Acceptable Manufacturers: Neotech Aqua Solutions, UV Pure Technologies.

C. UV-**[XXX]** Design Conditions
   1. Service: Bacterial Reduction
   2. Wavelength: 254 nm
   3. Dosage: 30,000 microwatt-sec/cm^2 after 9,000 hours
   4. Micro bacterial (E-coli) reduction: 99.9%
   5. Design Flow Rate: **[XXX]** gpm

D. UV-**[XXX]** Design Conditions
   1. Service: TOC reduction
   2. Wavelength: 185 nm
   3. Dosage: 30,000 microwatt-sec/cm^2 after 9,000 hours
   4. Organics reduction: **[99.9%]**
   5. Design Flow Rate: **[XXX]** gpm

E. Materials
   1. Wetted surfaces: 316L stainless steel electropolished to a surface finish of 15 Ra and passivated.

F. Connections shall be flange **[Tri-clamp]**.

G. Accessories: 2 "S" pattern light traps, 1 on inlet and 1 on outlet

H. Instrumentation
   1. Temperature sensor with shut down interlock, local alarm, dry contacts.
   2. UV intensity meter with local alarm and dry contacts.
   3. LED operating indicators for each UV lamp.
   4. Elapsed running time meter.
   5. Remote start/stop capability.

I. Electrical: 120 VAC; single phase, 60 Hz

2.13 STORAGE TANK

A. **[General: Provide tank as per [Section 22 6720.23 - Tanks for High Purity Service] [Section 22 6720.26 - Fiberglass Reinforced Plastic Tanks]]**

B. Description: polyethylene, cylindrical, atmospheric, closed top tank with flanged and covered manway.

C. Acceptable Manufacturers: **[Snyder Tanks, Polyprocessing, Chemtainer, or approved equal] [Protectoplas]**

D. Capacity: **XXX** gallons nominal

E. Tank to be one-piece, seamless construction of high-density linear polyethylene.

F. Polyethylene to be FDA approved for food contact as per 21 CFR 177.1520. Resin complies with ASTM D-1998.

G. Design for at least 1.9 specific gravity. Temperature is 60° to 80°F.

H. Tank shall be air-tight

I. Cone or dish bottom shall be totally drainable.

J. Indoor location

K. Dished top head

L. Epoxy coated (2 coats) steel, or plastic support, so that bottom tank nozzle is at least 18″ off of floor.

M. Nozzles:
1. Nozzles shall be welded inside and outside.
2. Nozzles shall all be flanged and gusseted.
3. A standard lid is unacceptable. Manway shall be flanged with gasketed, bolted cover.
4. Minimum size of nozzles is as per following schedule. Vendor is responsible to ensure adequate number and size of nozzles
5. Schedule

LOCATION	SERVICE	SIZE	CONNECTION	NOTES
Top	Manway	16″ min.	flange	Replace standard access port with a flanged nozzle
Top	Spare	2″	flange	
Top	Inlet	1″	flange	
Top	Vent	1.5″	flange	
Top	Breather	2″	flange	
Top, center	Loop return with Sprayball	3″	flange	
Top	Level transmitte r r	By Vendor	flange	[top or bottom depending on level transmitter]
Bottom center	Outlet	XXX″	flange	Provide Vortex Breaker

N. Quality Control:
1. Vendor shall have active quality control program.
2. Tank fabrication and all welds shall be inspected, and inspection shall be documented.

3. Testing shall conform to ASTM D-1998.
4. Tank shall be kept clean during and after fabrication consistent with use for high purity service.

2.14 STORAGE TANK PRESSURE / VACUUM RELIEF

A. Vendor shall provide pressure and vacuum relief to protect tank in the event of blockage of vent filter or overfilling due to failure of level controls.

B. Vendor shall ensure that relieving device does not open during normal operation, but opens adequately under excessive vacuum or pressure to protect tank.

C. Breather Valve
1. Description: Breather vent valve with pressure and vacuum relief
2. Acceptable Manufacturers: Protectoseal or approved equal
3. Design Conditions
   a. Pressure relief setting 12" water column
   b. Vacuum relief setting 12" water column
   c. Size: 2"
4. Mechanical
   a. Material: **[Aluminum][Stainless steel]**; Teflon seat
   b. Connections
      1) Tank: 2" Flange, 150# ANSI
      2) Pressure out 2" Flange, 150# ANSI
      3) Vacuum in: open

2.15 STORAGE TANK SPRAY BALL ASSEMBLY

A. Description: Static spray ball**[s]** with connecting piping

B. Sprayball
1. Acceptable Manufacturers: Sanimatic or approved equal
2. Design Conditions: **[XX]** gpm at **[XX]** psi
3. Material: .....316L stainless steel with 25 Ra finish; Teflon
4. Connection: Slip joint with stainless steel pin
5. Pattern:.....**[180 degrees upward; uniform coverage][Single-axis rotary spray]**
6. Features: .....Self draining

C. Piping
1. Specification: Piping as per referenced section.
2. Configuration: Piping to suspend ball**[s]** at location**[s]** that provide complete and uniform coverage spray to top of tank. Piping to attach to tank flange. Connection to return line shall conform to mechanical connections as per piping Section.

2.16 STORAGE TANK VENT FILTER

A. Description: Cartridge filter housing and hydrophobic sterile filter element for vent filtration.

B. Acceptable Manufacturers: Pall, Millipore, Sartorius, or approved equal

C. Design Conditions
1. Rating: 0.2 micron
2. Pressure Drop: 0.2 psid maximum at **[**8 scfm**]** **[XXX]**

D. Filter Housing:
1. Material: **[Polypropylene] [Stainless steel]**
2. Pressure Rating: 50 psig minimum
3. Gasket Material: Silicone
4. Configuration: **[In line] [T-style]**

E. Filter Element:
   1. Quantity: per Vendor
   2. Grade: Pharmaceutical, 0.2 micron absolute, hydrophobic
   3. Material: PVDF/Polypropylene

2.17 LOOP COOLER

A. Description: Sanitary, double tube sheet, shell and tube heat exchanger.
   1. Unit shall be installed on slip steam off high purity water loop as shown in drawings.
   2. Shell side shall be **[cooling] [chilled]** water.
   3. Control shall be manual.

B. Acceptable manufacturer: Exergy Series 35, double tubesheet, Model 01095-5, or approved equal

C. Following instrumentation shall be provided:
   1. Temperature gauge on chilled water return line.
   2. **[Sanitary temperature gauge on high purity water outlet pipe.]**
   3. Pressure relief valve (1/2") on chilled water line at exchanger for thermal expansion relief.
   4. Globe valve on outlet of chilled water.
   5. Controls are not required.

2.18 DISTRIBUTION PUMPS

A. Vertical, multistage, stainless steel centrifugal, Grundfos CRN or approved equal

B. Grundfos model CRN-XXXX

C. Design rating: **XXX** gpm at **XXX** ft

D. Surfaces in contact with water shall be 316 stainless steel.

E. Nozzles shall be **[150# ANSI flanges][Triclamp]**.

F. Seal shall be a single mechanical seal with a carbon rotating face and a tungsten carbide stationary seat.

G. Motor shall be TEFC, 460 V, 3 phase, VFD compatible

H. **[VFDs] [Motor starters with soft start]** shall be provided for motors by HPW equipment Vendor.

2.19 INSTRUMENTATION

A. General
   1. Instrumentation shall be provided to enable reliable, safe, and efficient operation of the system, and to meet the functional requirements of this specification.
   2. Instrumentation shown on the drawings identified in Part 1.1 and in this specification shall be provided.
   3. Instruments shall be appropriate for water quality level.
      a. Instrument in contract with water downstream of the RO unit shall be of sanitary design. Pressure sensors shall have diaphragm seals.
   4. Vendor shall ensure instruments are properly calibrated.

B. Production System
   1. Instruments integral to production system shall provide the required functionality with a high level of reliability.
   2. **[Hardness monitor shall be Hach SP510 or approved equal.]**
   3. **[Chlorine monitor shall be Hach CL17, ATI A15, or approved equal.]**

C. Distribution system:
   1. Resistivity and temperature transmitters shall be Thornton or approved equal.

a. Vendor shall provide calibration certification of installed unit.
b. Sensors for conductivity/resistivity shall be installed in run of a horizontal tee with flow exiting the upward branch.

2. Flow meters shall be sanitary turbine meters, 316 stainless steel, 3A rating; Flow Technology, Inc., Thornton, Hoffer Flow Controls, or approved equal;
   a. Straight pipe upstream and downstream of flow meters as specified by manufacturer
3. **[TOC monitor shall be Thornton or GE or approved equal. Vendor shall provide calibration certification of installed unit.]**
4. Tank level transmitter shall provide continuous measurement of water level.
5. Diaphragm seals shall be provided for all gauges and pressure transmitters on piping and equipment in distribution system. Alternatively, pressure gauges with 3A rating can be used.
6. Thermowells shall be 316 stainless steel, 3A rated.
7. Pressure regulators and backpressure regulators shall be installed with at least 10 pipe diameters of straight pipe upstream and downstream of regulator.
8. Self-contained backpressure regulator and gauge shall be provided on the end of the return line of the distribution loop.
   a). Specification as per referenced piping section
   b). Adjustable pressure range **XXX** to **XXX** psig.
9. Pressure Gauges shall have minimum 3.5" face.

D. Flow meter for recirculation line
1. Description: Rotameter
2. Manufacturer: Blue-White Series F-460 or approved equal
3. Range: **[**1 to 10 gpm**] [XXX]** water
4. Material:
   a. End Fittings: 316 SS
   b. Float and Rod: 316 SS
   c. Metering Tube: Acrylic
   d. O-Rings: Viton

2.20 CONTROL SYSTEM

A. General
1. Controls shall be provided to enable reliable, safe, and efficient operation of the system, and to meet the functional requirements of this specification.
2. Vendor shall provide:
   a. A dedicated control system to monitor and control the entire system
   b. Design of the control system, hardware, and software.
   c. Controls and instrumentation required to ensure proper operation of the equipment and to consistently and reliably produce and maintain the required water quality.
   d. Programming to accomplish the required functions. Programming shall be systematically tested, including challenge testing, and testing shall be documented.
   e. A functional Specification that completely describes the operation of the system and specifies the acceptable ranges for operating parameters.
3. This specification is written for systems that have a dedicated PLC on RO unit; and would require second PLC for distribution system. Optionally, a single PLC that would control entire system would be acceptable and preferable.

B. Hardware
1. PLC shall be an Allen Bradley MicroLogix or CompactLogix.
2. HMI shall be Allen Bradley **[Color Panelview Plus 1000 Plus][Panelview 550 Plus]**
3. System shall have 20% spare processing capacity and space for cards that would provide an

additional 20% I/O.

C. Functionality
1. System shall automatically:
   a. Operate the production system
   b. Start and stop of flow from the production system into the storage tank based on tank level.
   c. Stop the flow from the production system into the storage tank if the resistivity falls below the acceptable value or if key production operating parameters are out of range.
   d. Adjust the speed of distribution pump to maintain constant flow rate at end of loop.
      1) [The loop has one primary pump and one standby pump, with manual switchover][controls shall automatically switch operation of pumps at predetermined intervals.]
   e. Stop the distribution pump**[s]** if tank is below Low Low level.
   f. Turn UV light on and off
2. System shall continuously monitor and provide alarms for:
   a. [Hardness level in supply to RO]
   b. [Chlorine concentration in supply to RO]
   c. Tank levels
   d. Discrete alarm signals from RO, UV lights, and other equipment to ensure safe and proper operation of those units.
   e. Resistivity of water from the production system that is supplied to storage tank
   f. Distribution loop:
      1) Resistivity, on supply line
      2) Resistivity, flow, temperature on return
      3) [TOC]
   g. Distribution pump running
   h. Faults from distribution pump VFD.
   i. Status of distribution pump.
3. Control system shall provide:
   a. One discrete general fault output for connection to the BAS system corresponding to any alarm condition.
   b. An Alarm List.
   c. Capability of assigning multiple levels of alarms for all analog monitored parameters: low low, low, high, high high.
   d. Capability of providing a time delay for each alarm.
   e. Password protected, multilevel security to prevent change of primary operating parameters by unauthorized personnel.
4. Alarms:
   a. Vendor shall specify appropriate operating ranges and alarm setpoints for the production system.
   b. Alarm for the distribution system and preliminary setpoints shall be as follows:
      1) Storage Tank Level
         a) High High - Approx. 95% capacity: Provide Alarm.
         b) Full - Approx. 90% capacity
         c) Add - Approx. 75% capacity
         d) Low Low alarm - Approx. 50% capacity: Provide Advisory message. This level indicates that makeup is inadequate.
         e) Low - Approx. 5% capacity: Shut down distribution pumps and provide alarm. Pumps shall not start under Low Low level conditions.

2) Alarms shall only be active when pump has been in Automatic Mode for at least 1 minute.

5. Operator Interface (Panelview) shall:
   a. Provide graphical displays that show process in flow diagram format
      1) summary screen**[s]**
      2) Several individual screens, dividing the system into logical parts, sufficient to clearly and logically display content.
   b. Display:
      1) all monitored parameters on the graphics
      2) operation status of equipment
      3) Active Alarms
      4) Alarm History

D. Panels
1. NEMA 12 panel(s) shall be provided to contain controls, solenoids, operator interface, motor starters, step down transformers, and other devices required for system.
2. Panels shall be designed and listed in accordance with UL 508A.
3. Transmitters to be mounted in panels where feasible.
4. Power for transmitters and instrumentation shall be provided from panel.
5. Local horn and beacon for alarm conditions shall be provided. Provide alarm silence button.
6. Panels shall provide 20% minimum spare capacity of space, PLC chassis space, wireway space, and terminal blocks to allow for future expansion by adding I/O cards and associated cabling.

2.21 ELECTRICAL POWER

A. Vendor shall provide all panels, devices, wiring, local disconnects, VFDs and motor controls for the system.
1. A separate low voltage panel shall be provided for the PLC and HMI.
2. Panels shall be designed and listed in accordance with UL 508A.
3. An E-stop shall be provided.
4. Electrical components and installation shall conform to the NEC.
5. Equipment and installation shall conform to the latest requirements or state and local authorities having jurisdiction.
6. UL labeled equipment shall be provided to the full extent that UL labels are applicable.
7. Wiring shall comply with methods approved in NFPA 79.

B. Motors
1. NEMA Premier efficiency as per NEMA MG. 1-2003.
2. Service factor of 1.2 Shall not operate in service factor
3. TEFC
4. Conform to requirements of NEMA, IEEE, NSI, and NEC standards and shall be listed by UL for service specified.

C. Drops will be provided, under the electrical contractor's scope of work, at the following locations:
   1. Individual 110 VAC/1 ph./60 Hz drops to equipment prior to the reverse osmosis unit.
   2. One 480 VAC/3 ph./60 Hz drop to panel on the reverse osmosis unit.
   3. One drop 480 VAC/3 ph./60 Hz to a distribution system equipment panel.
   4. Vendor shall provide for distribution of power from these panels to accommodate all of Vendor's needs.
      a. Vendor will be responsible for transforming power as required.
      b. Vendor shall provide detailed instructions to Contractor covering any field wiring between Vendor equipment.
      c. Vendor shall provide local disconnects.

PART 3 - EXECUTION

3.1 CONTRACTOR RESPONSIBILITIES

A. Coordinate delivery of tank and skids with building construction to ensure that tank can be moved into building and set in place.

B. Inspect delivered equipment and components for evidence of damage or contamination

C. Rig, handle, store, set, and anchor equipment as per Vendor's recommendations and in manner that prevents impact damage and excessive stress.

D. Maintain a high level of cleanliness during handling and installation.
   1. Prior to starting work, identify areas that will be used for storage and fabrication, and take measures to prevent contamination from adjoining areas.
   2. Keep openings on assemblies sealed during fabrication to prevent contamination prior to final installation.

E. Provide housekeeping pads as indicated on the drawings identified in Part 1.1.
   1. Determine final size of pads based on approved Vendor submittal drawings.

F. Install equipment level and plumb.

G. Interconnect Vendor equipment as required
   1. Install HPW piping in compliance with specification in "Related Work"
   2. Connect utilities.

H. Ensure that the system is ready for safe startup.

I. Provide tagging for equipment, piping, and valves.

J. Coordinate startup, balancing, testing and turnover of system with Owner Representative and Vendor.
   1. Contractor shall be responsible for maintaining system in good working condition until final turn-over to Owner Representative. Contractor may choose to actively operate system or place system in safe, non-operational state if significant time period is anticipated prior to Owner turn-over.
      a. Contractor shall monitor system to assure all parameters are within specified ranges if system remains in operation. Contractor shall perform routine maintenance to keep system in proper operating condition.
      b. Contractor shall be responsible for protecting system from damage or degradation if system is to be placed in non-operational state. Procedures and protective measures shall comply with manufacturer's recommendations for storage. System shall be drained

and purged/dried with nitrogen to prevent corrosion. Contractor shall identify utility and other live system connections that should be isolated and locked out. Remove and store internal elements that can degrade if system is not operational. Provide written startup procedure for restoring system to operation.

3.2 VENDOR RESPONSIBILITIES

A. Provide a representative responsible for on-site activities:
   1. Verify that system is ready for startup.
      a. Inspect installation, interconnections, utility connections, vents, etc.
      b. Load media and filter elements as required.
      c. Conduct pre-startup check-out.
   2. Startup and test system.
      a. Verify proper operation in all operating modes.
      b. Adjust operation of equipment and controls to meet operational, water quality, and safety requirements, and update documentation as required.
      c. Test and balance distribution system and achieve stable operation at specified flow and pressure conditions.
      d. Adjust self-contained backpressure regulator at end of distribution loop to maintain pressure at its upstream pressure gauge at the design setpoint value.
         1) Verify system flows are as per design values
   3. Sanitize system as per procedure.
   4. Demonstrate to the Owner Representative or to the Commissioning Agent that system operates in accordance with requirements of this specification and per approved submittal documentation.
      a. Provide procedures that systematically verify that system operates as designed.
         1) Identification of acceptable ranges for all operating parameters.
      b. Draw samples from at least 4 locations on the distribution loop and provide the results of analysis indicating that the water meets the bacteria level requirement.
         1) Arrange for the bacterial analysis to be performed by an independent testing laboratory, using standard methods, compliant with the requirements of the water quality standard in Part 1.5.
      c. Calibrate resistivity and TOC monitors and provide calibration certification.
   5. Maintain operational oversight of system until Owner's organization is able to assume responsibility for operation.
   6. Provide Turn Over documentation as identified in Part 1.
      a. Documents shall include the final operational setpoints and information.
   7. Provide training for Owner
      a. Provide a program that covers overview, operator training, and maintenance training.
      b. Operations training shall include:
         1) Start-up procedure
         2) Shutdown procedure
         3) Emergency operations
         4) Safety procedures and hazards
         5) Alarm conditions and actions
         6) Parameter adjustments
         7) Security

END OF SECTION 22 67 20.13