FMOC

Specification Section 15051 Piping Systems

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Sandia National Laboratories

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Change Log

Rev. No.	Changed By	Date	Change Description	Pages Changed
0	DS/JCG	7/29/10	Deleted a reference to a manufacturer of thermoplastic butterfly valves. Changed the preferred manufacturer of chemical filter feeder to align the specification with current FMOC water-treatment goals. Added specification language for compressed air piping globe valves. Added a requirement for the Contractor to furnish water from a source other than that of the system being repaired or modified, if a hydrostatic test is being performed. Placed the specification in standard FMOC format, and reviewed it for punctuation and grammar.	All

Part 1 - General

1.01 Summary

A. Materials and operations required for the installation of piping systems, including pipe fittings, valves, equipment, joints, and tests for the following systems:

1. Steams and Condensate
   a. Aboveground
   b. Underground: Reference Sandia National Laboratories (SNL) Construction Standard Specification Section 02558, *Preinsulated Underground Pipe for Steam and Condensate Service*.
2. Heating Water, Chilled Water, and Process Water (including water/glycol solutions):
   a. Aboveground
   b. Underground: Reference SNL Construction Standard Specification Section 02551, *Underground Hydronic Distribution Systems*.
3. Tower Water Piping
   a. Aboveground
   b. Underground
4. Fuel Gas
   a. Aboveground
   b. Underground: Reference SNL Construction Standard Specification Section 02553, *Exterior Gas Piping Systems*.
5. Compressed Air
   a. Aboveground
   b. Underground
6. Vacuum
   - Aboveground

B. Pipe and fittings to be used for modifications or additions must be the same material as the existing systems being modified, but must conform to the following, unless otherwise indicated on the applicable contract drawings.

C. Piping materials and installation procedures must conform to ASME B31.3, *Process Piping*, the International Mechanical Code, and this Section.

1.02 References

The current editions of the following standards are a part of this specification:

A. SNL Construction Standard Specifications and Drawings

Number	Title
Section 01065	ES&H for Construction and Service Contracts
Section 01330	Submittal Procedures
Section 02200	Earthwork
Section 02551	Underground Hydronic Distribution Systems
Section 02553	Exterior Gas Piping Systems
Section 02558	Preinsulated Underground Pipe for Steam and Condensate
Section 09900	Painting
Section 15050	Basic Mechanical Materials and Methods
Section 15200	Vibration Limits and Control
Section 15083	Piping and Equipment Insulation
WG5007STD	Gas Meter Detail

B. American Society of Mechanical Engineers (ASME)

Number	Title
ASME	Boiler and Pressure Vessel Code
ASME B1.1	Unified Screw Threads
ASME B1.2	Pipe Threads, General Purpose
ASME B16.3	Malleable Iron Thread Fittings Classes 150 and 300
ASME B16.5	Pipe Flanges and Flanged Fittings
ASME B16.9	Factory-made Wrought Steel Butt Welding Fittings
ASME B16.11	Forged Fittings, Socket-Welding and Threaded
ASME B16.18	Cast Copper Alloy Solder-Joint Pressure Fittings
ASME B16.22	Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings
ASME B16.24	Bronze Pipe Flanges and Flanged Fittings, Class 150 and 300
ASME B16.33	Manually Operated Metallic Gas Valves for Use in Gas Piping Systems up to 125 psi (Sizes NPS ½ through NPS 2)
ASME B16.34	Valves - Flanged, Threaded, and Welding End
ASME B31.3	Process Piping
ASME B40.100	Pressure Gauges and Gauge Attachments Incorporating ASME B40.1 and ASME B40.7

C. American Society for Testing and Materials (ASTM)

Number	Title
ASTM A53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A126	Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A153	Zinc Coating (Hot Dip) on Iron and Steel Hardware

Number	Title
ASTM A182	Forged or Rolled Alloy Steel Pipe Flanges, Forged Fittings and Valves and Parts for High-Temperature Service
ASTM A193	Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
ASTM A194	Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service
ASTM A234	Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
ASTM A307	Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
ASTM A536	Standard Specification for Ductile Iron Castings
ASTM B43	Standard Specification for Seamless Red Brass Pipe, Standard Sizes
ASTM B61	Standard Specification for Steam or Valve Bronze Casting
ASTM B88	Standard Specification for Seamless Copper Water Tube
ASTM B280	Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
ASTM B687	Standard Specification for Brass- , Copper -, and Chromium-Plated Pipe Nipples
ASTM B819	Standard Specification for Seamless Copper Tube for Medical Gas Systems
ASTM B828	Standard Practice for Making Capillary Joint by Soldering of Copper and Copper Alloy Tube and Fittings
ASTM D 2000	Standard Classification for Rubber Products …
ASTM F402	Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings
ASTM F437	Standard Specification for Threaded CPVC Plastic Pipe Fittings, Schedule 80
ASTM F439	Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F441	Standard Specification for CPVC Plastic Pipe, Schedules 40 and 80
ASTM F1476	Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications

D. American Water Works Association (AWWA)

- ANSI/AWWA C606 AWWA Standard for Grooved and Shouldered Joints

E. American Welding Society (AWS)

Number	Title
AWS A5.8	Specification for Brazing Filler Metal
AWS B2.1-8-005	Standard Welding Procedure Specification for Gas Metal Arc Welding of Austenitic Stainless Steel, 18 through 10 Gauge, in the As-welded Condition, with or without Backing Site License
AWS B2.2	Standard for Brazing Procedure and Performance Qualification

F. International Code Council (ICC)

- International Mechanical Code (IMC)
- International Plumbing Code (IPC)
- International Fuel Gas Code (IFGC)

G. American Gas Association (AGA)

H. Copper Development Association

1.03 Submittals

A. General

All required submittals must be per SNL Construction Standard Specification Section 01330, *Submittal Procedures*. Submittal data is only required on products proposed as substitutions to those that are listed in this specification or when such data is specifically required by the universal construction package's descriptive submittal form. Product-submittal data must indicate the maximum allowable operating pressure and temperature of each component and any related manufacturing standard.

B. Submittal Data Required

1. As-Built Drawings: Upon completion of the work, the Contractor must revise all drawings to agree with the construction materials, capacities, locations, and routing as actually accomplished. The notation "As-Built" must be entered in the revision block, dated, and initialed.
2. ASME-Rated Pressure Vessels: Two copies of the manufacturer's data report for ASME-rated pressure vessels must be submitted in the O&M package.
3. All certifications for welders and brazers must be submitted to the Mechanical SNL Construction Observer (SCO), for verification of quality assurance at least two weeks before starting any work. The procedures and certifications will be reviewed by the SNL-designated certified welding inspector.
4. Calibrated Balancing Valves: Provide submittal data that includes calibration curves.

1.04 Quality Assurance

A. Welding, Brazing, or Soldering

1. Qualify welding/brazing processes and welder/brazer performance in accordance with AWS B2.2, *Standard for Brazing Procedure and Performance Qualification*, or ASME *Boiler and Pressure Vessel Code*, Section IX. Certify that each welder/brazer has satisfactorily passed AWS or ASME qualification tests for welding/brazing processes involved and, if pertinent, have undergone recertification.
2. Welding and brazing procedures must address cleaning, joint clearance, overlaps, internal purge gas, purge gas flow rate, and filler metal.
3. Certification of procedures and operators applies for both shop and job site welding and brazing of pipe work.
4. Operators must comply with SNL Construction Specification 01065, *ES&H for Construction and Service Contracts*, Section 1.05.E, Hot Work Permit.
5. Performance qualification of welders/brazers must remain in effect indefinitely unless the welder/brazer does not weld or braze with the qualified procedure for a period exceeding 12 months, or there is a specific reason to question the ability of the welder/brazer.

6. Soldering: Conform to ASME B31.3, *Process Piping,* and Copper Development Association recommended practices.

B. Grooved Joints

1. All grooved-joint couplings, fittings, valves, and specialties must be the products of a single manufacturer. All pipe and groove dimensions must be within the tolerances specified in ANSI/AWWA C606. The Contractor is responsible for grooving pipe to the dimensions that are compatible with the manufacturer's specified tolerances for its products.
2. All castings used for coupling housings, fittings, valve bodies, and similar products must be date-stamped for quality assurance and traceability.
3. The grooved-coupling manufacturer's factory-trained representative must provide training for Contractor's field personnel in the use of grooving tools and installation of grooved-joint products.

C. Fuel Gas Piping and Equipment Installation in the State of New Mexico

Contractor must be licensed by the State of New Mexico Regulation and Licensing Department - Construction Industries Division, and must use licensed gas fitters.

D. Copper or Bronze Pressure-Sealed Joints

1. Installers of Copper or Bronze Pressure-Sealed Joints: Pipefitters must be certified by the pressure-joint fitting manufacturer as having been trained and qualified to join copper pipe with pressure-seal fittings.
2. Copper pressure-seal fittings must be installed using the proper tool, actuator, jaws, and rings as instructed by the press-fitting manufacturer.

1.05 Delivery, Storage, and Handling

A. Deliver materials to the job site in good condition and properly protected against damage to finished surfaces.

B. Storage Onsite

Store materials in a location and in a manner to avoid damage. Stacking must be done in a way that prevents bending. Store components and materials in a clean, dry location. Cover with waterproof paper, tarpaulin, or polyethylene sheeting in a manner that permits circulation of air inside the cover. All components, specifically piping, must have open ends capped or sealed such that debris cannot accumulate internally during the duration of their storage and installation.

C. Keep handling onsite to a minimum. Exercise care to avoid damage to finishes of material.

D. Use a sling to hoist large valves. Do not use hand wheels or stems as lifting or rigging points.

Part 2 - Products

2.01 Acceptable Manufacturers

The following products and materials must be used unless shown otherwise on the drawings. Other products of equal or better quality and characteristics may be submitted in addition to those listed in this specification. All products and materials must be of new, unused condition unless such have been provided by SNL.

2.02 Materials for Aboveground Saturated-Steam Systems

A. Piping

1. Saturated Steam: Schedule 40 black steel, ASTM A53, Grade B, Type S (seamless), with butt-welded joints, except threaded joints allowed for sizes 2 inches and smaller.
2. Condensate: Schedule 80 black steel, ASTM A53, Grade B, Type S (seamless), with butt-welded joints, except threaded joints allowed for sizes 2 inches and less.

B. Fittings

1. Malleable-Iron Threaded Fittings: ASME B16.4, Class 300.
2. Malleable-Iron Unions: ASME B16.39, Class 300.
3. Forged-Steel Threaded and Socket-Weld Fittings: ASME B16.11, Class 2000 and 3000.
4. Wrought Steel Butt-Welded Fittings: ASME B16.9, equal in thickness to meet pipe pressure ratings.
5. Forged-Steel Branch Fittings (such as Weld-O-Lets™ or Thread-O-Lets™): MSS-SP-97, with thickness to meet pipe pressure ratings.
6. Cast- or Forged-Steel Flanges: ASME B16.5, Class 150, Material Group 1.1, welding neck, raised face (or faced to match adjoining valves, components and equipment), and including bolts, nuts and gaskets.

C. Gaskets

0.175" thick with ⅛" solid-metal stay ring. Material is 304 stainless steel with chlorocarb graphite filler. Flexitallic™, Style CG or Lamons Spiraseal™ Style WR or equivalent.

D. Bolts and Nuts

Bolts must conform to ASTM A193, Grade B7. Nuts must conform to ASTM A194/A194M Rev A, Grade 2H.

E. Valves

1. Gate (30 to 125 psig service):
   a. 2 inches and smaller: Class 150, union bonnet, rising stem, cast bronze, solid-wedge disc, with threaded ends. Nibco T-134.
   b. 2½ inches and larger: Class 150, cast steel ASME B16.34, Valves - OS&Y, rising stem, flanged ends. Trim must be bronze per ASTM B61 or 316 stainless steel. Crane 47.
2. Gate (under 30 psig):
   a. 2 inches and smaller: Class 125, bronze body, threaded ends, rising stem, union bonnet, and solid-wedge disc. Nibco T-124.
   b. 2 to 3 inches: Class 125, iron body, OS&Y, flanged ends, bolted bonnet, and rising stem. Nibco F-617-O.
   c. 4 inches and larger: Class 150, bolted bonnet, ductile iron body, flanged ends, OS&Y, solid wedge, bronze trim. Nibco F-637-31.
3. Globe:
   a. 1½ inches and smaller: Class 200, stainless steel plug disk and seat ring, bronze body, union bonnet, and threaded ends. Nibco T256-AP.
   b. 2 inches and larger: Class 150, ductile-iron body conforming to ASTM A- 395, OS&Y, bronze trim, flanged ends, bolted bonnet, bronze disc, replaceable seats. Nibco F-738-31.
4. Check: 2 inches and smaller: Class 150, bronze, swing check, Y style, TFE disc, screw caps, and screwed ends. Nibco T-433-Y.
5. Needle: 1 inch and smaller: Positive shutoff for gauges and manual air vents, brass. Weiss Instruments 25NVBR.

F. Strainers

1. 1½ inches and smaller: Maximum saturated steam pressure 250, screwed ends, Y pattern with stainless steel screen - 20 mesh (0.033" openings). Spirax-Sarco Type "IT."
2. 2 inches and larger Y style: Class 250, cast iron, flanged, with perforated stainless steel screen (2" to 3", 0.033" perforations for steam or water; 4" to 6", 0.045" perforations for steam, 0.125" perforations for water; 8" to 16", 0.062" perforations for steam, 0.125" perforations for water). Spirax-Sarco Type CI-125 or CI-250.
3. 2-inch to 12-inch basket strainer: Class 250, cast iron, flanged, quick-opening top-access clamped cover, with perforated stainless steel basket strainer (2" to 3", 0.045" perforations for steam or water; 4" to 6", 0.045" perforations for steam, 0.125" perforations for water; 8" to 12", 0.062" perforations for steam, and 0.125" perforations for water). Spirax-Sarco Type 733.

G. Traps

Size traps for pressure and flow and application.

1. Thermostatic, for saturated-steam service: Angle, vertical or horizontal, brass or stainless steel body, screwed union type, stainless steel bellows, and replaceable stainless steel seat. Spirax-Sarco Types TH-25, TH-125, and TA-125.
2. Float and Thermostatic, for saturated-steam service: Iron body, all stainless steel interior components, screwed. Spirax-Sarco Types FT-15, FT-30, or FT-125.
3. Thermodynamic, for saturated-steam service: Stainless steel body, hardened stainless steel working surfaces. Spirax-Sarco TD- 52 or TD-42.

H. Air Vents

- Balanced-Pressure Thermostatic Air Vent: Ductile iron body, stainless steel internals, self-adjusting balanced pressure thermostatic type. Spirax-Sarco VS 204 or equivalent.

I. Vacuum Breaker

- Vacuum Breaker, brass body, stainless steel valve, capable of operating at conditions of 210 psig saturated steam. Spirax-Sarco VB14 or equivalent.

2.03 Materials for Space Heating, Chilled, Process, and Tower Water Systems

A. General

Pipe and fittings to be used in modifications, repairs, or additions must be of the same material (steel, copper, or plastic) as the existing system being modified or repaired and must conform to the following unless otherwise indicated on the applicable contract drawings.

B. Piping

1. Aboveground:
   a. Type L hard-drawn copper tubing, ASTM B88 with soldered, brazed, or copper/bronze pressure-seal joints.
   b. Black steel, welded (Type E) or seamless (Type S), ASTM A53, Grade B, Schedule 40 up to 10 inches and standard weight above 10 inches with threaded, welded, grooved, or flanged joints.
   c. CVPC, schedule 80, ASTM F 441/F441M. Applicable to process chilled-water systems only, not to be installed in exterior locations or applied to heating water systems.
2. Underground Tower Water Piping: Schedule 40 black steel, seamless Type S or welded Type E, Grade B, ASTM A53. Installed protective pipe coating systems must be of the same materials throughout.
   a. Fittings and Joints: All joints in underground piping must be welded using Schedule 40 forged-steel butt-weld fittings. All welding must conform to the requirements of SNL Construction Standard Specification Section 15050, *Basic Mechanical Materials and Methods*. Use of unions and flanges underground is prohibited. Fittings and joints must be protected with Polyken No. 1027 primer and Polyken No. 930-35 tape coating, 35 mil, 21 kV

dielectric strength, as manufactured by Tyco adhesives, Corrosion Protection Group. Minimum 1-inch overlap required.

b. Protective pipe covering must be factory- or field-applied according to manufacturer's written instructions. Products must be Polyken No. 1027 primer and Polyken No 930-35 tape coating, 35 mil 21 kV dielectric strength, as manufactured by Tyco adhesives, Corrosion Protection Group. Minimum 1-inch overlap required.

c. Epoxy Coatings: 3M epoxy coatings may be used in place of the Polyken pipe coatings. 3M Scotchkote™ 6233, Fusion-Bonded Epoxy Coating, must be facility-specified and applied at 15-mil thickness for pipe and fittings. 3M Scotchkote 323, Liquid Epoxy Coating, must be facility-specified and applied at 25-mils thickness. Epoxy coatings must be applied according to manufacturer's written instructions. The coating, pipe, or joint must be inspected for continuity in accordance with NACE Standard RP0490-01, *Holiday Detection Fusion-Bonded Epoxy.*

C. Fittings

1. Malleable-Iron Threaded Fittings: ASME B16.4, Class 150.
2. Malleable-Iron Unions: ASME B16.39, Class 150.
3. Wrought and Cast Copper and Copper Alloy Solder-Joint Fittings: ASME B16.18 and B16.22.
4. Forged-Steel Threaded and Socket-Weld Fittings: ASME B16.11, Class 2000 and 3000.
5. Wrought-Steel Butt-Welded Fittings: ASME B16.9, equal in thickness to meet pipe pressure ratings.
6. Grooved Joint Fittings: ASTM A536 ductile iron; ASTM A234 wrought steel; or factory-fabricated from steel pipe conforming to ASTM A53; with factory-grooved ends. Victaulic Company or approved equal.
7. Grooved-Joint Couplings: Grooved-joint couplings must consist of two ductile iron housing segments, pressure-responsive EPDM or EHP gasket, and zinc-electroplated steel bolts and nuts. Victaulic Company or approved equal.

   a. 2 inches to 12 inches:

      - Rigid Type: Housings must be cast with offsetting angle-pattern bolt pads to provide rigidity and system support and hanging in accordance with ANSI B31.1 and B31.9.
      - Flange Adapter: Flat-face, ductile-iron housings with EPDM pressure-responsive gasket for direct connection to ANSI Class 125 or 150 flanged components.

   b. 14 inches through 24 inches: Advanced Groove System (AGS) style with lead-in chamfer on housing key and wide-width gasket, 300 psi maximum working pressure.

      - Rigid Type: Housing key must fill the wedge-shaped AGS groove and provide rigidity and system support and hanging in accordance with ANSI B31.1 and B31.9.
      - Flexible Type: Housing key must fit into the wedge-shaped AGS groove and allow for linear and angular pipe movement.
      - Flange Adapter: Flat-face, ductile-iron housings with EPDM pressure-responsive gasket, for direct connection to ANSI Class 125 or 150 flanged components.

8. Forged-Steel Branch Fittings (such as Weld-O-Lets™ or Thread-O-Lets™): MSS-SP-97, with thickness to meet pipe pressure ratings.
9. Flanges
    a. Steel: Cast and forged steel, ASME B16.5, Class 150, Material Group 1.1, welding neck, slip-on, or threaded, raised face (or faced to match adjoining valves, components and equipment), and including bolts, nuts, and gaskets.
    b. Bronze: Class 150 bronze flange per ASME B16.24. Threaded or solder joint.
10. Threaded brass fittings and nipples, ASTM B 43, ASTM B 687.
11. Dielectric nipples or couplings: Electroplated steel nipple or coupling with inert noncorrosive thermoplastic lining, rated for 300 psig at 225°F.
12. CVPC Fittings: Schedule 80 socket-type per ASTM F439 and schedule 80 threaded fittings per ASTM F437.
    - CPVC Fittings with a Female Adapter Component: All female-adapter fittings used in the transition from metal to thermoplastic pipe must be supplied with a reinforced collar of stainless steel around the threaded joint for added protection.
13. Copper or Bronze Pressure-Seal Fittings: Copper or bronze housing, factory-installed EPDM sealing element, 200 psi working pressure with a 0 to 250°F temperature rating. ASME B16.18 and B16:22, ASTM B 88 and D 2000. Rigid ProPress™ or Stadler-Viega.

D. Flange Gaskets

Material must be of compressed sheet suitable for the operating conditions. Group 1a or 1b as listed in ASME B16.5.

E. Flange Bolts and Nuts

Bolts must conform to ASTM A193/A193M Rev B, Grade B7. Nuts must conform to ASTM A194/A194M Rev A, Grade 2H.

F. Valves

1. Gate:
    a. 2 inches and smaller: Bronze or brass body, 200 psi nonshock working pressure, solder or threaded ends, screwed bonnet, and full port. Bronze body - Nibco S-111 or Nibco T-111. Brass body – Nibco SI-8 or TI-8.
    b. 2½ inches and larger: Iron body, 200 psi nonshock cold working-pressure rating, flanged ends, OS&Y, bronze trim, rising stem, and solid wedge. Nibco F-617-0.
2. Ball:
    a. 2 inches and smaller:
        - Two-Piece Body: Bronze or brass body, 600 psi nonshock working pressure, blow-out-proof captive stem, double Teflon seats, full-ported, stainless steel or chrome-plated brass ball, threaded or soldered ends. Bronze body: Nibco T-585-70 or S-585-70. Brass body: Nibco T-FP-600 or S-FP-600.

- System Drain Applications: May use a valve with integral hose connection, cap, and chain; full-port, blow-out-proof stem, double Teflon seats, and rated for 600 psi nonshock working pressure. Nibco 585-70-HC.

- Three-Piece Body: Bronze body, 600 psi nonshock working pressure, blow-out-proof captive stem, double Teflon seats, full-port, stainless steel trim, and threaded or soldered ends. Nibco T or S-595-Y.

b. 2½ inches to 3 inches: Two- or three-piece bronze or brass body, 400 psi nonshock cold working pressure, blow-out-proof captive stainless steel stem, double Teflon seals and seats, full-ported, stainless steel or chrome plated brass ball and threaded ends. Nibco T-595-Y-(66-SS) or Nibco T-FP-600.

c. 4 inches and larger: Class 150, flanged ends, carbon steel body with 316 stainless steel trim, Unit-body design, full-ported, blow-out-proof captive stainless steel stem and ball, and Teflon seat. Nibco F-510-CS-R-66-FS.

3. Globe:

a. 2 inches and smaller: Class 125, screwed ends, bronze body, inside screw, screw-in bonnet, renewable seat and disc. Nibco T-211.

b. 2½ inches and larger: Class 125, iron body conforming to ASTM A126 Class B, bronze trim, flanged ends, bolted bonnet, bronze disc, replaceable seats. Nibco F-718-B.

4. Butterfly:

a. Lug Type:

- 2½ inches through 6 inches: 200 psi working pressure, ductile iron body, aluminum/bronze disc, EPDM liner, stainless steel shaft, resilient seat, O-ring seals, lug type for dead-end service, lever operator. Nibco LD2000 series.
- 8 inches and larger: 150 psi or 200 psi working pressure, ductile iron body, aluminum/bronze disc, EPDM liner, stainless steel shaft, resilient seat, O-ring seals, lug type for dead-end service, gear operator. Nibco LD1000 or LD2000 series dependent on the application.

5. Check Valve:

a. 2 inches and smaller: Class 125, threaded ends, bronze body, Y pattern, renewable seat and disk, and screw cap. Nibco T-413

b. 2½ inches and larger:

- Flanged Type: Class 125, iron body, silent check, flanged ends, globe style, spring-actuated, renewable seats and disc, bronze trim or 316 stainless steel trim. Nibco F-910.
- Grooved-End Type: 300 psi working pressure, ductile iron body, vertical or horizontal check, grooved ends, spring-actuated single disc, and stainless steel shaft.

6. Vertical Check: 2 inches and smaller: Class 125, threaded ends, bronze body, spring actuated, inline vertical lift type, TFE seat ring. Nibco T-480-Y.

7. Needle: 1 inch and smaller: Rated at 600 psi and 300°F, positive shut-off for gauges, brass. Weiss Instruments 25NVBR.

8. Thermoplastic (Cpvc) Valves:

a. Ball: 2 inches and smaller: True-union body, rated for 225 psi at 70°F, CVPC body, blow-out-proof captive stem, Teflon seats, socket ends, full-port design, and EPDM or Viton seals. Approved manufacturers: Hayward, George Fisher, or Spears.

b. Butterfly: 1 1/2" and Greater: Rated for 150 psi at 73°F, CVPC body, 316 stainless steel shaft and hardware, 100% positive seal, and EPDM or Viton disc seals.

G. Strainers

1. 2 inches and smaller: Threaded or solder ends, wye-pattern, cast-bronze body with retainer cap tapped for closure plug, 400 psi at 150°F, and 20-mesh 304 stainless steel screen for water service. Watts series 777S or S777S. Keckley F or E-300.
2. 2½ inches and larger:
   a. Flanged Type: Wye-pattern, cast iron body and bolted cap, 200 psi at 150°F, screen cap tapped for closure plug, standard perforation stainless steel screen for water service. Keckley Style A series.
   b. Grooved-End Type: 300 psi working pressure, wye-pattern ductile iron body and coupled cap, EPDM seals, standard mesh stainless steel screen for water service.

H. Flexible Connectors

1. 2 inches and smaller: Threaded or socket ends, Type 321 stainless steel or bronze corrugated inner tube and wire-braid outer shield, MetraFlex™ SST, BBT, or BBS.
2. 2½ inches and larger: Elastomer connector, solid plate steel, Class 150 flanged ends, constructed of neoprene and nylon, temperature-rated at no less than 240°F. Control units must be installed per manufacturer's instructions. MetraFlex Metrasphere™ style O.

I. Glycol-Resistant Materials

All materials installed in a system containing a water/glycol solution must be resistant to (compatible with) glycol. Suitable materials include steel, iron, and bronze (red brass).

J. Bypass Feeder/Chemical Filter Feeder

A chemical bypass feeder must be installed on all heating and chilled-water loops and piped according to mechanical standard drawing MP5013STD.dgn. The bypass feeder must be a 5-gallon Neptune FTF-5HP filter feeder capable of an operating pressure up to 300 psig, operating temperature up to 200ºF, and flow up to 40gpm with a maximum initial pressure drop of 3 psi. The feeder must contain a stainless steel filter bag screen, with polypropylene replacement bag filter. Feeder must have fill, inlet, outlet, and drain ports.

K. Calibrated Balancing Valves, 2 Inches and Smaller

Bronze body, ball type, 200 psig working pressure, 250°F maximum operating temperature, and threaded ends. Valves must have calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, and must be equipped with a memory stop to retain set position.

Bell and Gossett Series Model CB. Provide calibration curves with submittals. Size valves for operation in the midsection of curves at the coils specified flow rate.

L. Calibrated Balancing Valves, 2-1/2 Inches and Larger

Cast-iron or steel body, ball or globe type, 175-psig working pressure, 250°F maximum operating temperature, and flanged connections. Valves must have calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, and must be equipped with a memory stop to retain set position. Bell and Gossett Series Model CB. Provide calibration curves with submittals. Size valves for operation in the midsection of curves at the coils specified flow rate.

M. Flexible Hose and Fitting

¼" – ¾" hose and fitting for final lab equipment connection assemblies. Synthetic rubber tube, textile-braid reinforcement, polyester braided cover, low-pressure hose. Operating temperature range: -40°F to 212 F, water not to exceed 150 F, air not to exceed 165 F. Maximum operating pressure 150 psi. Aeroquip FC647 hose with Aeroquip Socketless™ hose fittings. Flexible hose connections are not permitted in concealed areas or for heating and cooling coil installations.

N. Hydronic Piping Packages

All individual or combination components must meet the individual component specifications stipulated in the 15051 design standard with the exception that the isolation valves may be of standard port. Flexible hoses must be 24" or less in length. Hose construction must be EPT or EPDM tube with stainless-steel-braid reinforcement. Each hose must have at least one swivel or union end. All components must have a working temperature range of 0° to 212°F and a working pressure rating of 300 psi. Hose must be fire-rated per UL-94. Hose installation must be kept as straight as possible, but in no case must the maximum bend radius stipulated by the manufacturer be exceeded. Multiple bends in a single hose are not allowed.

2.04 Materials for Aboveground Fuel Gas and Liquified Propane Gas Systems

A. Piping, Indoor or Outdoor

Schedule 40 black steel or Schedule 40 galvanized steel, seamless Type S or welded Type E, ASTM A53/A53M. Pipe must be painted per SNL standard specification 09900.

B. Fittings

1. 2 inches and smaller: Class 150, banded malleable iron, screwed, ASME B16.3. Galvanized fittings must be hot-dipped in accordance with ASTM A153.
2. 2½ inches and larger: Class 150, banded malleable iron, screwed, ASME B16.3, or Schedule 40 wrought-steel butt-weld fittings, ASME B16.9.

C. Valves

Shutoff valves must be constructed of materials compatible with the piping. Shutoff valves installed in a portion of a piping system operating above 0.5 psig, and outdoors must comply with ASME B16.33. Shutoff valves installed in a portion of a piping system operating at 0.5 psig or less must comply with ANSI Z21.15 or ASME B16.33.

1. Plug:
    a. Outdoor systems, 2 inches and smaller: Cast iron body, threaded ends, flat-head lock-wing, nonlubricated full-port brass plug, 100 psig natural or propane gas rating, rated for use in ambient temperatures between -20°F and 150°F, A.Y. McDonald 10687B. If an insulating union is required, the same requirements would be applied, A.Y. McDonald 6266 series.
    b. Outdoor systems, 2½ inches and greater: Cast iron or ductile iron body, ANSI 125 flanged, seals rated for gas, nonlubricated eccentric-type one-piece plug, natural or propane gas rating, Milliken Millicentric Series 600.
    c. Indoor systems, appliance shutoff valve: Brass body and plug, lock-wing head, threaded ends, 25 psig rating, A.Y. McDonald Series 10621.
    d. Indoor systems, 2½ inches and greater: Cast iron or ductile iron body, ANSI 125 flanged, seals rated for gas, nonlubricated eccentric-type one-piece plug, natural or propane gas rating, Milliken Millicentric Series 600.
2. Ball:
    a. Outdoor systems operating above 0.5 psig: 100% full port, hot-forged brass body, double Viton o-rings, PTFE seats, integral lockout device, valve certified to 175 psig. Jomar model no. 175LWN.
    b. Appliance equipment applications, systems operating at less than 0.5 psig: Forged-brass body, fluorocarbon o-rings, PTFE seats, valve certified to 0.5 psig. Nibco GB Series.

D. Appliance Connectors, systems operating at less than 0.5 psig

Stainless steel or coated stainless steel, corrugated, ANSI Z21.24, Connectors for Gas Appliances, certified for indoor and outdoor use. Brasscraft model no. SSC or CSSC.

E. Strainer

1. Outdoor Systems:
    a. 2 inches and smaller: Cast iron body with screen retainer cap threaded for closure plug, threaded ends, wye pattern, 400 psi at 150°F WOG, and #20 mesh 304 stainless steel screen.
    b. 2-1/2 inches and larger: Cast iron body with screen retainer cap threaded for closure plug, flanged ends, wye pattern, 285 psi at 100°F WOG, and #20 mesh 304 stainless steel screen.
2. Indoor Systems:
    a. 2 inches and smaller: Cast iron or bronze body with screen cap threaded for closure plug, threaded ends, wye pattern, 400 psi at 150°F WOG, and #20 mesh 304 stainless steel screen.
    b. 2-1/2 inches and larger: Cast iron body with screen cap threaded for closure plug, flanged ends, wye pattern, 285 psi at 100°F WOG, and #20 mesh 304 stainless steel screen.

2.05 Materials for Compressed Air Systems (200 psig and Under)

A. General

Pipe, joints, and fittings to be used for modifications or additions must be of the same material (steel or copper) and joint (solder, brazed, threaded, or pressure-seal) as the existing system being modified or repaired and must conform to the following unless otherwise indicated on the applicable contract drawings.

B. Piping

1. Aboveground: Cleaned for oxygen service, Type L, hard-drawn copper tubing, ASTM B88 or ASTM B819, or hard-drawn ACR copper tubing of equal internal diameter, ASTM B280. Steel piping for modifications to existing systems must be schedule 40 black steel, seamless or welded per ASTM A53.
2. Underground: Cleaned for oxygen service, Type L, hard-drawn copper tubing, ASTM B88 or ASTM B819, or hard-drawn ACR copper tubing, ASTM B280. Steel pipe for modification to existing systems: Schedule 40 black steel, seamless Type S or welded Type E, Grade A or B, ASTM A53.

C. Joints

1. Aboveground:
   a. Steel: All joints must be welded using Schedule 40 forged-steel butt-weld fittings. All welding must conform to the requirements of Section 15050, *Basic Mechanical Materials and Methods*.
   b. Copper: All copper joints between the air compressor and its receiver, or within underground piping, or in any piping subject to service temperatures greater than 200ºF, or within piping systems with designed operating pressures of greater than 150 psi must be brazed or threaded. All aboveground copper joints in clean dry air systems must be brazed, threaded, or pressure-seal joints. General Service compressed air systems without clean dry air constraints of particle count, hydrocarbon removal, or moisture removal may use solder joint construction if approved by the design engineer.
2. Underground:
   a. Steel: All joints in underground piping must be welded, using Schedule 40 forged-steel butt-weld fittings. All welding must conform to the requirements of Section 15050, *Basic Mechanical Materials and Methods*. The installation of unions underground is prohibited.
   b. Copper: All joints must be brazed with an argon or nitrogen purge applied. The installation of flanges or unions underground is prohibited.

D. Underground Pipe and Fitting Corrosion Protection

1. Steel: Installed protective pipe coating systems must be of the same materials throughout. Protective pipe covering must be factory- or field-applied according to manufacturer's written instructions. Coatings must extend above grade at least 6 inches. Products must be Polyken No. 1027 primer and Polyken No. 930-35 tape coating, 35 mil, 21 kV dielectric strength, as manufactured by Tyco adhesives, Corrosion Protection Group. Minimum 1-inch overlap

required. Epoxy Coatings: 3M epoxy coatings may be used in place of the Polyken pipe coatings. 3M Scotchkote 6233, Fusion-Bonded Epoxy Coating, must be facility-specified and applied at 15 mils thickness for pipe and fittings. Epoxy coatings must be applied according to manufacturer's written instructions.

2. Copper: Installed protective pipe coating systems must be of the same materials throughout. Protective pipe covering must be factory- or field-applied according to manufacturer's written instructions. Coatings must extend above grade at least 6 inches. Products must be Polyken No. 1027 primer and Polyken No. 930-35 tape coating, 35 mil, 21 kV dielectric strength, as manufactured by Tyco adhesives, Corrosion Protection Group. Minimum 1-inch overlap required.

E. Fittings

1. Wrought copper and bronze braze joint, ASME B16.22, ASTM B88. Threaded brass fittings and nipples, ASTM B 43, ASTM B 687. For modifications to existing steel systems: Class 150 banded malleable iron, screwed, ASME B16.3; Schedule 40 wrought-steel butt-weld fittings, ASME B16.9.
2. Flanges: Flanges must be Class 150 bronze flanges, ASME B16.24, or for a modification to an existing steel system, Class 150 forged-steel flanges conforming to ASME B16.5.
3. Copper or Bronze Pressure-Seal Fittings: Copper or bronze housing, factory-installed EPDM sealing element, and a maximum 200 psi working pressure with a 0 to 250°F temperature rating. ASME B16.18 and B16.22, ASTM B 88 and D 2000. Rigid ProPress or Stadler-Viega.

F. Gaskets

Material must be of compressed sheet suitable for the operating conditions. Group 1a or 1b as listed in ASME B16.5.

G. Bolts and Nuts

Bolts must conform to ASTM A193/A193M Rev A, Grade B7. Nuts must conform to ASTM A194/A194M Rev A, Grade 2H.

H. Flexible Connectors

1. 2 inches and smaller: Threaded or socket ends, corrugated inner tube and wire-braid outer shield, Type 321 stainless steel. MetraFlex SST.
2. 2½ inches to 6 inches: Flanged ends, corrugated inner tube and wire-braid outer shield, Type 321 stainless steel. MetraFlex MLP or SLP.

I. Valves

1. Gate:
   a. 3 inches and smaller: Class 150, threaded ends, bronze body, rising stem, union bonnet and solid wedge. Nibco T-134.
   b. 4 inches and larger: Class 150, flanged ends, OS&Y, cast steel or ductile iron body, bronze trim, bolted bonnet, rising stem. Nibco F-637-31 or equivalent.

2. Ball:

   a. 2 inches and smaller: 600 psi CWP, bronze body, blow-out-proof captive stainless steel stem, double Teflon seals and seats, full-ported stainless steel ball. Nibco T-585, 2-piece and threaded ends or Nibco S-595-Y-66, 3-piece and solder ends.

   b. 2½ inches and larger: Class 150, flanged ends, carbon steel body with 316 stainless steel trim, blow-out-proof captive stainless steel stem and ball, double Teflon seals and seats. Nibco F510 Series.

3. Needle:

   - 1 inch and smaller: Rated at 600 psi and 300ºF, positive shut-off for gauges, brass. Weiss Instruments 25NVBR.

4. Globe:

   a. 2 inches and smaller: Class 125, screwed ends, bronze body, inside screw, screw-in bonnet, renewable seat and disc. Nibco T-211.

   b. 2½ inches and larger: Class 125, iron body conforming to ASTM A126 Class B, bronze trim, flanged ends, bolted bonnet, bronze disc, replaceable seats. Nibco F-718-B.

2.06 Materials for Process Vacuum Systems

A. General

Materials must be as follows unless otherwise indicated on the applicable contract drawings.

B. Pipe and fittings to be used for modifications, repairs, or additions must be the same material (steel, copper, or plastic) as the existing systems being modified or repaired and must conform to the following unless otherwise indicated on the applicable contract drawings.

C. Piping

Type L hard-drawn copper tubing with soldered joints, ASTM B88, or Type 304 stainless steel, or Schedule 80 CPVC per ASTM F441.

D. Fittings

1. Wrought copper and bronze solder-joint, ASME B16.22; or Schedule 40 wrought-steel butt-weld fittings, ASME B16.9, or CPVC schedule 80, ASTM F 437.
2. ¼-inch to 2-inch tube fittings: Carbon steel and 316 stainless steel. Swagelok.
3. ¼-inch to 1-inch weld fittings: Carbon steel, 316 stainless steel. Cajon.
4. CPVC fittings: Schedule 80 socket-type per ASTM F439 and schedule 80 threaded fittings per ASTM F437.
   a. Threaded fittings are only permitted at pipe-to-equipment connections.

b. CPVC fittings with a female adapter component: All female adapter fittings used in the transition from metal to thermoplastic pipe must be supplied with a reinforced collar of stainless steel around the threaded joint for added protection.

E. Flanges

Flanges must conform to ASME B16.5.

F. Gaskets

Material must be of compressed sheet suitable for the operating conditions. Group 1a or 1b of ASME B16.5.

G. Bolts and Nuts

Bolts must conform to ASTM A193, Grade B7. Nuts must conform to ASTM A194, Grade 2H.

H. Valves

1. Ball:

   Vacuum service to Class 125.

   a. 2 inches and smaller: Class 125 screwed or soldered ends, bronze body, and O-ring seal swing-out body, Worcester Series 44.

   b. 2½ inches and larger: Class 125, flanged ends, bronze O-ring seal, Worcester Series 45.

   c. CPVC body, EPDM o-ring seals, true-union design, socket end, rated for full vacuum service. Asahi/America Type 21 Duo-Bloc™ Ball Valve.

2. Needle:

   - 1 inch and smaller: Positive shut-off for gauges and manual air vents, brass. Weiss Instruments 25NVBR or equivalent.

2.07 Equipment

A. General

Equipment required for installation on this contract must be as specified on the applicable contract drawings and must be furnished complete with all accessories normally supplied with the catalog item listed and all other accessories necessary for a complete and satisfactory operating system.

B. Compressed Air Receivers

1. Prior to installation and acceptance, a pressure vessel operated at pressures of 15 psig or greater furnished under this contract must be stamped with an ASME Boiler and Pressure Vessel Code Symbol and a National Board of Boiler and Pressure Vessel Inspector's number. This certifies that the vessel has been fabricated and tested per the provisions of the ASME *Boiler and*

Pressure Vessel Code. Manufacturers' data reports (unless exempted by the ASME Code) are filed with the National Board in Columbus, Ohio. Two copies of these data reports must be submitted to Sandia National Laboratories. Testing, certification, and registration are at the expense of the Contractor. ASTM A-515- and ASME SA-515-type steels must not be used in the fabrication of pressure vessels.

2. Receiver must be equipped with shut-off valve and properly sized ASME certified pressure-relief valve.

C. Pressure-Relief Valves

Valves must be ASME National Board certified, registered, and stamped. The valves must be factory-set to maintain an operating or standby pressure as directed or noted.

D. Thermometers and Thermowells

Thermometers must be digital readout, solar-powered, union NPT connection, and with an ABS case. Each thermometer must be provided with a separable brass thermowell consisting of a properly sized bore. The well must be the length required for accurate reading of the measured media. Where thermometers occur in the insulated piping systems, or on insulated equipment, extension necks (lagging) must be provided so that the thermometer casing is outside of the insulation. Digital range must be -40°F to 300°F with a 3/8" LCD display and a 1% of reading accuracy. Weiss model number DVU 35 or Weksler model number AADHFC.

E. Pressure Gauges

Gauges for machine rooms, equipment rooms, and Central Utility Buildings (CUBs) must be industrial-type pressure gauges with safety-type rear blowout plug or panel, clear plastic lens, case consisting of one integral polypropylene part, ±0.5% accuracy, 4½" dial size. Weksler Series HA14. Gauges for point-of-use applications (such as process chilled-water drops, fan coil units, or user equipment) must be utility-type, HVAC gauges, bronze bourdon tube and brass socket, steel case, and plastic face 2½" dial size. Weksler Series 25TL. Range must be two times the system normal operating pressure. Gauges must be installed with snubbers and ¼" bronze needle valves. All gauges for steam systems must be provided with ¼" bronze needle valves, siphon tubes, and snubbers.

F. Automatic Air Vents

Air vents must be B&G Model 87 with brass bodies, all nonferrous internals and 150 psi maximum operating pressure. Vents must be capable of accepting ¼" O.D. copper tubing.

Part 3 - Execution

3.01 Piping Installation

A. General

Piping installation must be coordinated, with respect to space available, with heating, ventilating, and electrical installation. In every instance where there is a conflict in the routing of the piping and the ducting, the routing of the ducting must govern. Installed piping must not interfere with the operation or accessibility of doors or windows; must not encroach on aisles, passageways, and equipment; and must not interfere with the servicing or maintenance of equipment. Pipe must be cut accurately to measurements established at the construction site and must be worked into place without springing or forcing, properly clearing all openings and equipment. Cutting or weakening of structural members to facilitate piping installation is not permitted. Pipes must have burrs removed by reaming and must be so installed as to permit free expansion and contraction without damage to joints or hangers. Aboveground piping must be run parallel with the lines of the building unless otherwise noted on the drawings. Unless otherwise shown on the drawings, horizontal piping must pitch down in the direction of flow with a grade of not less than 1 inch in 40 feet. Service pipe, valves, and fittings must be located a sufficient distance from other work to permit the installation of the finished covering not less than ½" from such other work, and not less than ½" between the finished covering on the different services.

B. Reducers

Reduction in pipe sizes must be made with one-piece reducing fittings. Forged bushings are acceptable **only** with the approval of the SNL Mechanical Construction Observer (SCO), and when there is no room for reducing couplings, and the reduction is less than two pipe sizes. Bushings must not be used for fuel gas service. Only eccentric reducers are permitted in steam applications. Cast bushings **are not** acceptable.

C. Unions

All piping unions must be of the ground-joint type, constructed from materials equivalent in alloy composition and strength to other fittings specified with which they are used. Union pressure classes and end connections must be the same as the fittings used in the lines with the unions.

- Joining dissimilar materials (copper to steel). Use dielectric nipples, dielectric couplings, brass nipples, brass valves, or brass unions between copper and steel piping 2 inches and smaller. Use dielectric flange kits on larger piping. Dielectric unions must not be used to join two dissimilar metals (ferrous and nonferrous metallic piping.)

D. Installation of Valves

Valves must be installed at the locations shown on the drawings and where specified. All valves must be installed with their stems orientated horizontal or vertical and with sufficient clearance to allow for full-stem travel and the repair of two-piece or three-piece valves in place.

E. Hangers and Anchors

1. All piping must be rigidly supported from the building structure by means of adjustable ring-type, clevis, or band-type hangers. (Welding to the building structure is not permitted unless approved by the Structural Engineer.) Where pipes run side by side, support on rod and angle iron or Unistrut trapeze hangers. Hanger spacing must be as follows:

   a. Horizontal:

Steel Piping	Maximum Spacing
⅜" and smaller	4'-0"
½" through 1"	6'-0"
1¼" and larger	10'-0"

Copper Piping	Maximum Spacing
⅜" and smaller	4'-0"
½" through 1¼"	6'-0"
1½" and larger	10'-0"

   - All Other Piping Materials: Pipes must be supported in accordance with the Piping Support Spacing table of the International Mechanical Code.

   b. Vertical: Steel and copper piping must be supported at 10'-0" intervals, maximum spacing.

   - All Other Piping Materials: Pipes must be supported in accordance with the Piping Support Spacing table of the International Mechanical Code.

2. Round rods supporting the pipe hangers must be of the following dimensions unless otherwise specified on the project drawings by a professional structural engineer:

Pipe	Rod
⅜" to 2" pipe	⅜" rod
2½" to 3" pipe	½" rod
4" to 5" pipe	⅝" rod
6" pipe	¾" rod
8" through 12"	⅞" rod
14" through 16"	1" rod

3. Rods for trapeze hangers must be a minimum of ⅜" and must have the equivalent cross section, listed in Section 3.01.E.2, per pipe supported. The use of pipe hooks, chains, perforated iron strapping, or wire for pipe supports is not permitted.
4. Hanger rods must be galvanized or zinc-plated carbon steel per ASTM A307 Grade B, threaded per ASME B1.1 with a coarse-thread series, and with a Class 2A fit.

   a. All hanger rod connections must use double-nut fastening. Hanger rods must not extend more than one inch past the double nut or beam clamp.

5. Hanger rods must be installed vertically. No offset in hanger rod is permitted.
6. Place a hanger within 1'-0" of each horizontal elbow.

7. Use hangers that are vertically adjustable 1½" minimum and a maximum of 2" after piping is erected.
8. Use copper-plated materials, PVC-coated materials, or nonconductive isolators on copper pipe and ferrous materials on ferrous pipes.
9. Soft copper tubing, where permitted, must be fastened to the building structure with Unistrut-type clamps and spaced not more than 6'-0" apart.
10. On 4" and larger piping, install hangers adjacent (within 1'-0" on each side) of strainers, check valves, valves, and all flanged items.
11. C-clamp-style hanger must only be installed with retaining clip.
12. In grooved-pipe installations, use rigid couplings with offsetting angle-pattern bolt pads that permit support and hanging in accordance with ANSI B31.1, B31.3, and B31.9.

F. Piping Equipment Supports and Fastenings

Fixtures and equipment must be solidly supported and securely fastened. Installation must include suitable backing to anchor all hanging fixtures and equipment.

G. Air Vents (for Closed-Loop Water and Water/Glycol Systems)

1. Automatic Air Vents: A manual valve must be installed ahead of each automatic air vent. Brass body, for use on hot or cold water, with threaded outlet adaptable to ¼" O.D. copper tube.
   a. Do not install automatic vent valves in a glycol system.
   b. A drain line should be connected to the vent hole and piped to the nearest floor drain or floor sink.
2. Manual: A shutoff valve must be installed ahead of each manual air vent. Where air vent locations are 10'-0" or more above the floor, ¼" O.D. copper tubing must be installed at the point of venting and extended down with the needle valve installed to an accessible position. All vents lower than 10 feet must have a candy cane installed that would allow easy access for venting in a bucket. All vents that would become inaccessible after the completion of construction must be extended to an accessible location. Each branch and main system high point must be vented to permit removal of all air from the system.

H. Equipment Connections

All piping connections to pumps and other equipment must be installed without strain at the pipe connection of the equipment. The Contractor must be required as directed by the SNL Mechanical Construction Observer (SCO) to remove the bolts in flanged connections or disconnect piping to demonstrate that the piping has been so connected. Pipe connections to equipment must be made with unions, grooved-pipe mechanical couplings, or flanged fittings.

I. Joints

1. Flanged Joints: All flanged joints must be face matched. Raised face flanges must not be mated to flat-faced cast-iron flanges on valves or equipment. The raised face must be machined flush. All flange bolt holes must straddle the horizontal and vertical centerlines unless otherwise noted. Install insulating kits on flanges connecting dissimilar metals, such as steel to copper, to prevent

electrolytic action. Bolting must comply with ASME B31.3, *Process Piping*. Torque values and tightening sequence for bolts must be in accordance with flange manufacturer's instructions.

2. Threaded Joints: Threaded-pipe joints must have American Standard Taper Pipe Threads complying with ASME B1.2. Care must be taken that the inside of pipe is thoroughly clean and free of cutting oil and foreign matter before installation. Metal-screwed pipe joints must be made leak-tight using Teflon tape, pipe-thread lubricant, or Teflon tape and a pipe-lubricating compound. Thermoplastic threaded pipe joints must be made leak-tight per product manufacturer's recommendations. When joining thermoplastic threaded pipe to metal threaded piping, attempts should be made to screw the plastic pipe into female metal pipe fittings to reduce the likelihood of plastic fitting failure.
3. Solder-Joints: Tubing must be cut square, reamed, and burrs removed. Both the inside of fittings and the outside of tubing must be well-cleaned with sand cloth or wire brush before sweating. Care must be taken to prevent annealing of fittings and hard-drawn tubing when making connections. Solders containing lead or cored solders are not permitted. Joints must conform to ASTM B828. Joints must comply with ASME B31.3, *Process Piping*, and the Copper Development Association.
    a. Solder containing antimony **must not** be used to join metals containing zinc (for example, galvanized iron, galvanized steel, and brass).
    b. Use sand cloth or a stainless steel wire brush to clean surfaces to be joined.
    c. Solder End Valve: Use a gate, globe, two-piece or three-piece ball valve for solder-end valves. When joining a solder-end valve, ensure valve is fully open. Apply heat to tube first. Transfer as much heat as possible through the tube to the valve. Avoid prolonged heating of the valve. Use a noncorrosive paste flux and solid-wire solder suitable for the service temperatures and pressures expected.
4. Brazed Joints: New copper systems must be installed with socket-type fittings and with an argon or nitrogen purge applied. Flux must not be used except when joining specialty items and fittings that are not available in copper. Brazing filler metals must comply with AWS A5.8, *Specification for Brazing Filler Metals*. Copper-to-copper joints must be brazed using a copper-phosphorus or copper-phosphorous-silver brazing filler metal (BCuP) without flux. Copper-to-bronze or copper-to-brass joints must be brazed using an appropriate flux with 45% silver (Bag-5 series) brazing filler metal. The following procedure must be followed:
    a. Tube ends must be cut square using a sharp tubing cutter. The wheel must be free of grease, oil, and dirt. The cut end of the tubing must be deburred with a sharp, clean deburring tool, taking care to prevent chips from entering the tube or pipe.
    b. The surfaces to be brazed must be cleaned mechanically. Joints must be recleaned if they become contaminated prior to brazing. Joints must be brazed within 1 hour of being cleaned.
    c. Where dissimilar metal joints, such as copper to bronze or brass, are being brazed, flux must be applied sparingly to minimize contamination of the inside of the tube with flux. Where possible, short sections of copper tube must be brazed to the noncopper components, and the interior of the subassembly must be cleaned of the flux prior to installation in the piping system. Flux-coated brazing rods may be used in lieu of the application of flux to the surfaces to be joined for tubes ¾" size and smaller.
    d. While being brazed, joints must be continuously purged with oil-free dry nitrogen or argon to prevent the formation of copper oxide on the inside surface of the joint. The flow of the purge gas must be maintained until the joint is cool to the touch.

e. Exception: A final connection to an existing system must be permitted without the use of a purge gas.

f. During and after installation, openings in the piping system must be kept capped or plugged to avoid unnecessary loss of purge gas and to prevent contamination. Do not begin brazing until piping is fully purged of air. For continuous runs of piping, brazing must begin at the purge port area and continue through the system. The purge connection must not be changed. While brazing, a discharge opening must be provided on the opposite side of the joint from where the purge gas is introduced. During brazing, the purge gas flow rate must be maintained at a level that does not produce positive pressure in the piping system. While welding, the minimum purge rate must be 15 scfh for ¼" tubing or 25 scfh for all tubing ⅜" and larger. Purge must continue after completion of braze until the joint is cool.

g. After brazing, the outside of all joints must be cleaned by washing with water and a stainless steel brush to remove any residue and permit clear visual inspection of the joint. Where flux has been permitted, hot water must be used.

5. Swagelok Compression Fittings: Follow the manufacturer's installation instructions for assembling tubing and tube fittings. Use a sharp clean tube-cutter wheel to cut tubing. Remove burrs, chips, and scratches from the end of the tubing. Ensure that the tubing is fully bottomed in the fitting before final tightening. After assembly, check that the fitting is properly tightened by using a Gap Inspection Gauge.

6. Welded Joints: Joints between sections of pipe and between pipe and fittings may be welded using either gas or electric welding equipment. Stainless steel welding must conform to AWS B2.1-8-005. All pipe surfaces must be thoroughly cleaned before welding. Each joint, except socket-weld joints, must be beveled before being welded. The Contractor must provide a nonflammable mat or blanket to protect the structure and adequate fire protection equipment at all locations where welding is done. All elbows must be long radius where space conditions allow. Wherever branch connections are made to piping systems on the main run, welding sockets or Weld-O-Lets may be used in lieu of reducing outlet tees for branch connections up to one-half the size of the main run. On connections larger than one-half the size of the main run, welding tees must be used. The use of fittings formed from welded pipe sections is not permitted. All welding must conform to the requirements of SNL Construction Standard Specification Section 15050, *Basic Mechanical Materials and Methods*. Any welding work requires the following:

   a. A hot work permit from SNL Fire Protection.

   b. A dedicated fire watch during the work process until thirty (30) minutes after completion.

   c. A minimum 2-A-rated fire extinguisher located near the welding site.

   d. Any other special requirements listed on the permit.

7. Solvent Cement Joints: CPVC and all thermoplastic pipe solvent cement joints must follow the manufacturer's installation instructions for assembly of joints with respect to pipe size and ambient conditions. All installations must comply with ASTM F 402, *Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings.*

8. Copper or Copper Alloy Pressure-Seal Joints: Copper and copper alloy press connections must be made in accordance with the manufacturer's installation instructions. The tubing must be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment

must be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) into the fitting. The joints must be pressed using tools approved by the manufacturer.

9. Grooved joints must be installed in accordance with the manufacturer's latest published installation instructions. Grooved ends must be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Gaskets must be of an Elastomer grade suitable for the intended service, and must be molded and produced by the coupling manufacturer.
10. System Drains: Drains indicated on the drawings in connection with water distribution systems must be no smaller than ¾" IPS. Install valve with bronze caps or plugs, unless otherwise noted. Additional drains must be installed at low points on the hot water and chilled water piping to ensure proper draining of the system, and all piping must pitch to the drains. System drains used on 14-inch and larger piping systems, must use a minimum 1½-inch drain. Ball or gate valves with hose-end fitting and cap must be provided as drain valves at low points.

J. Discharge from pressure-relief valves must be piped full-size and extended to a nearby floor sink or to the outside of the building structure, unless otherwise shown on the drawings.

K. Insulation of all pipes, valves, fittings, and equipment must be in accordance with Section 15083, *Piping and Equipment Insulation*, unless noted otherwise on the drawings.

L. Identification and Labels

All piping systems must be labeled and identified in accordance with Section 15050, *Basic Mechanical Materials and Methods.*

M. Cross-Connection Prevention

1. A reduced-pressure backflow-prevention assembly (RPBA) must be installed to prevent cross-connection contamination between potable water systems and nonpotable, potentially polluted, or contaminated systems, such as drainage systems, soil lines, fire protection lines, or chemical lines.
2. All potable water fixture outlets with hose attachments, such as hose bibbs, janitor sinks, or lab sinks, must be protected by an approved (SCO or IAPMO) vacuum-breaker device.
3. Reduced-pressure backflow-prevention assemblies must be approved by the Foundation for Cross-Connection Control and Hydraulic Research, University of Southern California (USC-FCCCHR).
4. Backflow-prevention assemblies used or installed under this contract must be tested by a Certified Backflow Control Assembly Tester who possesses a current (within 3 years from date of issuance) certificate that confirms the successful completion of an approved (SCO-specified or USC-FCCCHR, or Colorado Environmental Training Center, Golden, Colorado) training course.
5. The Contractor must perform an operational test on any new or relocated backflow-prevention assemblies used or installed under this contract. Passing backflow preventers must be labeled with a tag indicating the test performed, the tester's initials, and the date. Testing documentation must be submitted to the SCO.

6. Repairs to reduced-pressure backflow-prevention assemblies must be made with original manufacturer's parts.
7. Piping downstream of reduced-pressure backflow-prevention assemblies must be labeled "Nonpotable" or "NPW" in accordance with Section 15050, *Basic Mechanical Materials and Methods.*
8. All RPBA devices must be installed at a maximum distance of 5 feet from finished floor with a 1-foot clearance maintained on all sides for ease of maintenance.
9. Adequate drainage must be provided for the RPBA and meet the following:
    a. Discharge must be piped full size (of the relief valve) and extend to a location shown on project drawings.
    b. Discharge piping must be sloped minimum 1/8" per foot.

N. Compressed-Air Receivers

Install receiver with sufficient clearance to allow access to manhole or armhole.

O. Gas Meters

Reference SNL standard drawing gas meter detail number WG5007STD for proper installation of gas service to buildings.

P. Gas Regulators

Reference SNL standard drawing gas meter detail number WG5007STD for proper installation of gas service to buildings.

Q. Instrumentation

Local temperature and pressure instrumentation located in mechanical equipment rooms must be of industrial quality and should be easily read from a normal vantage point from within the area. If instrumentation is placed in piping or ducts 10' above the finished floor, a large 5-inch dial must be used for ease of reading. Local instrumentation installed on point-of-use equipment must be of a commercial utility quality, and that can be easily read from a vantage point near the equipment. Outdoor instrumentation must be protected with weather shields.

3.02 Tests

A. General

Before insulation is applied, all piping, equipment, and accessories installed under this contract must be inspected and pressure-tested by the Contractor in the presence of the SCO and approved before acceptance. The Contractor must furnish all labor, material, and equipment required for testing. If a hydrostatic test is to be performed, the Contractor must furnish the water from a source other than that of the system that is being repaired or modified. The use of data-logging instrumentation is recommended for testing. The Contractor must be responsible for all repairs and retesting as required. All instruments and equipment whose safe pressure range is below that of the test pressure

must be removed from the line or blanked off before applying the tests. For test, the Contractor must provide a 4-inch or greater diameter pressure gauge with 1% full-scale accuracy. Pressure ranges and scale graduations for piping systems are specified in the following test pressure table.

B. Testing

1. Steam, condensate, hot water, chilled water, process water, and tower water piping must be tested hydrostatically at the test pressures specified and must show no drop in pressure in a 2-hour period.
2. Fuel gas and compressed air piping must be tested using compressed air or dry nitrogen as indicated at the test pressures specified and must show no drop in pressure in a 2-hour period. Immediately after fuel gas is turned on in a new system, the piping must be tested for leakage; gas leaks must be located by a noncorrosive leak-detector fluid.
3. Process Vacuum piping must be tested using a 23-inch Hg vacuum and must show no rise in pressure for 15 minutes; vacuum leaks must be located by ultrasonic leak detection. DO NOT use pressure testing on plastic piping systems! Severe damage or bodily injury can result.

C. Test Pressures

Unless otherwise specified or noted in the following table, hydrostatic test pressure must be 1.5 times the system operating design pressure, and pneumatic test pressure must be 1.25 times the system operating design pressure, whichever is greater.

Table 1. Test Pressures

Test Pressure (psig or vacuum)					
System	**Test Gauge Range**	**Test Gauge Graduation**	**Hydrostatic**	**Pneumatic**	**Vacuum**
Steam (31-125 psig)	300 psig	2 psig	225	NA	NA
Steam (0-30 psig)	100 psig	1 psig	50	NA	NA
Steam Condensate	200 psig	2 psig	100	NA	NA
Heating Water and Chilled Water	200 psig	2 psig	150	NA	NA
Process Water Systems	1.5 times test pressure	2 psig	1.5 times design	NA	NA
Tower Water	200 psig	2 psig	100	NA	NA
Aboveground Fuel Gas	60 psig	0.5 psig	NA	25	NA
Compressed Air (0-30 psig)	100 psig	1 psig	NA	60	NA
Compressed Air (31-165 psig)	300 psig	2 psig	NA	250	NA
Compressed Air (Above 165 psig)	1.5 times test pressure	2 psig	NA	1.5 times design	NA
Process Vacuum	30"-0 Hg	2"	NA	NA	23" Hg

D. Flushing and Cleaning

Coordination for flushing and cleaning of the systems must be through the SCO to ensure that all systems, components, and controls are in place to execute Section 15189, *Chemical Treatment*.

END OF SECTION