SPECIAL SPECIFICATION

SECTION 15051S

PIPING SYSTEMS

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PIPING SYSTEMS

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. Heating Water, Chilled Water (including water/glycol solutions), and Tower Water:

   a. Aboveground

   b. Belowground

2. Process Chilled Water: Reference Section 15511S.

3. Natural Gas:

   a. Aboveground

   b. Belowground: Reference Sandia Construction Standard Specification Section 02553, Exterior Gas Piping Systems

4. Compressed Air (for MicroLab and WIF):

   a. Reference Section 15K-S for CUB-1/MicroFab Clean Dry Air.

   b. Aboveground

   c. Belowground

4. Vacuum Systems: Reference Section 15216S for MicroFab House Cleaning Vacuum and Section 15461S for MicroFab Plant Vacuum.

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

C. Piping materials and installation procedures shall conform with ASME B31.1, Power Piping, the International Mechanical Code, and this specification.

1.02 REFERENCES

The current editions of the following standards and specifications are a part of this specification.

A. Sandia National Laboratories MESA Special Specifications:

Section 01300S, Descriptive Submittals

Section 02200S, Earthwork

Section 09900S, Painting

Section 15050S, Basic Mechanical Materials and Methods

Section 15070S, Vibration Limits and Control

Section 15075S, Mechanical Identification

Section 15123S, Meters & Gages

Section 15250S, Pipe and Equipment Insulation and Accessories

B. American Society of Mechanical Engineers (ASME) and ANSI:

ASME	Boiler and Pressure Vessel Code
ANSI B1.1	Unified Screw Threads
ANSI B1.2	Pipe Threads, General Purpose
ANSI B16.3	Malleable Iron Thread Fittings Classes 150 and 300
ANSI B16.5	Pipe Flanges and Flanged Fittings
ANSI B16.9	Factory-made Wrought Steel Butt Welding Fittings
ANSI B16.11	Forged Fittings, Socket-Welding and Threaded
ANSI B16.22	Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings

ANSI B16.24	Bronze Pipe Flanges and Flanged Fittings Class 150 and 300
ANSI B16.33	Manually Operated Metallic Gas Valves for Use in Gas Piping Systems up To 125 psi (Sizes NPS ½ Through NPS 2)
ANSI B16.34	Valves - Flanged, Threaded, and Welding End
ASME B31.1	Power Piping
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)

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 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 B61	Standard Specification for Steam or Valve Bronze Casting
ASTM B88	Seamless Copper Water Tube
ASTM B280	Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
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

D. American Welding Society (AWS)

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

E. International Conference of Building Officials (ICBO)

IMC International Mechanical Code

IPC International Plumbing Code

F. American Gas Association (AGA)

G. Copper Development Association

1.03 SUBMITTALS

A. All required submittals shall be per Specification Section 01300S, Descriptive Submittals.

B. All pipe materials, valves, equipment, and accessories shall be submitted for approval. Product data shall indicate the maximum allowable operating pressure and temperature of each component and any related manufacturing standard.

1. As-Built Drawings: Upon completion of the work, the Contractor shall revise all drawings to agree with the construction materials, capacities, locations, and routing as actually accomplished. The notation "As-Built" shall be entered in the revision block, dated, and initialed.

2. Two copies of the manufacturer's data report for pressure vessels built to ASME Section VIII requirements shall be submitted in the O&M package.

1.04 QUALITY ASSURANCE

A. Welding or Brazing:

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, has undergone re-certification.

2. Welding and brazing procedures shall 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 shall have completed the Sandia National Laboratories Welding Safety Class.

5. Performance qualification of welders/brazers shall 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.

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

C. Natural Gas Piping and Equipment Installation: Contractor shall be licensed by the State of New Mexico Regulation and Licensing Department - Construction Industries Division, and shall use licensed pipe fitters.

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. Conform to requirements of Section 15050S for storage, protection, and handling.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

The following products and materials shall be used unless shown otherwise on the drawings. Other manufacturers of products of equal or better quality and characteristics may be submitted on in addition to those listed in this specification. The manufacturers listed under this section supply products of acceptable type, quality, and performance.

2.02 MATERIALS FOR SPACE HEATING, CHILLED, AND TOWER WATER SYSTEMS (including water/glycol solutions)

A. Piping:

1. Aboveground:

a. 2 Inches and Smaller: Type L hard drawn copper tubing, ASTM B88 with soldered joints.

b. 2½ Inches and Larger: 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 welded or flanged joints or type L hard drawn copper tubing, ASTM B88 with soldered joints below 3 inches and brazed joints 3 inches and larger.

B. Fittings:

1. Malleable-Iron Threaded Fittings: ASME B16.4, Class 300.

2. Malleable-Iron Unions: ASME B16.39, Class 300.

3. Wought and Cast Copper and Copper Alloy Solder Joint Fittings: ANSI B16.18 and B16.22.

4. Forged Steel Threaded and Socket Weld Fittings: ANSI B16.11, Class 2000 and 3000.

5. Wrought Steel Butt Welded Fittings: ANSI B16.9, equal in thickness to meet pipe pressure ratings.

6. Forged Steel Branch Fittings (weldolets, threadolets, etc.): MSS-SP-97, with thickness to meet pipe pressure ratings.

7. Cast and Forged Steel Flanges: ANSI 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.

C. Gaskets: Material shall be of compressed sheet suitable for the operating conditions. Group 1a or 1b as listed in ANSI B16.5.

D. Bolts and Nuts: Bolts shall conform to ASTM A193/A193M Rev B, Grade B7. Nuts shall conform to ASTM A194/A194M Rev A, Grade 2H.

E. Valves:

1. Gate:

a. 1-inch and smaller: Class 125, solder or threaded ends, bronze body, rising stem, screwed bonnet, and solid wedge. Nibco S-111 or Nibco T-111 or equivalent.

b. 1¼ Inches to 2-inch: Class 125, threaded ends, bronze body, rising stem, screwed bonnet, and solid wedge. Nibco T-111 or equivalent.

c. 2½ Inches and larger: Class 125, flanged ends, OS&Y, iron body, bronze trim, rising stem, and solid wedge. Nibco F-617-0 or equivalent.

2. Ball:

a. 2 Inches and Smaller: bronze body, blow-out proof captive stem, double Teflon seats, full ported, stainless steel or chrome plated brass ball, 2-piece, threaded or soldered ends. Nibco T-585-70-66 or S-585-70-66. Or a 3-piece bronze body, full port, stainless steel trim, with a blowout-proof stem. Nibco T or S-595-Y or equivalent.

b. 2½ Inches to 3 Inches: Two or three-piece bronze body, 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-585-70-66 or Nibco T-585-Y-66.

c. 4 Inches and Larger: Class 150, flanged ends, carbon steel body with 316 stainless steel trim, uni-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 or equivalent.

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 or equivalent.

4. Butterfly:

a. 2½ Inches through 6 Inches: 200 psi working pressure, iron body, aluminum/bronze disc, stainless steel shaft, resilient seat, O-ring seals, lug type for dead-end service, lever operator. Nibco LD2000-3 series.

b. 8 Inches and Larger: 150 or 200 working pressure, iron body, aluminum/bronze disc, stainless steel shaft, resilient seat, O-ring seals, lug type for dead-end service, gear operator. Nibco LD1000-5 or LD2000-5 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 or equivalent.

b. 2½ Inches and Larger: 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 or equivalent.

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 or equivalent.

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

F. Strainers:

1. 2 Inches and Smaller: Threaded ends, cast bronze body with screwed cap, and 20-mesh 304 stainless steel screen for water service. Conbraco 59-000 series or equivalent.

2. 2½ Inches and Larger: Flanged ends, cast iron body and bolted cap, 20-mesh stainless steel screen for water service. Conbraco FC1 or equivalent.

G. Flexible Connectors:

1. 2 Inches and Smaller: Threaded ends, corrugated inner tube and wire braid outer shield, Type 321 stainless steel. MetraFlex SST or BBT or equivalent.

2. 2½ Inches and Larger: Elastomer connector, solid plate steel 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.

H. Glycol-Resistant Materials: All materials installed in a system containing a water/glycol solution shall be resistant to (compatible with) glycol. Suitable materials include steel, iron, and bronze (red brass).

I. Bypass Feeder/Chemical Filter feeder: Chemical by-pass feeder shall be installed on all heating and chilled water loops and piped according to mechanical standard drawing MP5013STD.dgn, detail no. 15J-17. The by-pass feeder shall be either a 2- or 5-gal Efficiency Dynamics Inc. No. FF-100 filter feeder capable of: an operating pressure up to 150 psig, operating temperature up to 200ºF, and flow up to 40 gpm/maximum initial pressure drop of 3 psi. The feeder shall contain a stainless steel filter bag screen, with polypropylene replacement bag filter.

J. Calibrated Balancing Valves, 2 Inches and Smaller: Bronze body, ball type, 200-psig working pressure, 250 deg F maximum operating temperature, and having threaded ends. Valves shall have calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, and be equipped with a memory stop to retain set position. Bell and Gossett Model CB-_. Provide calibration curves with submittals Size valves for operation in the midsection of curves at the coils specified flow rate.

K. Calibrated Balancing Valves, 2-1/2 Inches and Larger: Cast-iron or steel body, ball or globe type, 175-psig working pressure, 250 deg F maximum operating temperature, and having flanged connections. Valves shall have calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, and be equipped with a memory stop to retain set position. Bell and Gossett Model CB-_. Provide calibration curves with submittals Size valves for operation in the midsection of curves at the coils specified flow rate.

2.03 MATERIALS FOR NATURAL GAS SYSTEMS (aboveground, for belowground natural gas piping, see Sandia Construction Standard Specification Section 02553, Exterior Gas Piping Systems)

A. Piping: Schedule 40 black steel, seamless Type S or welded Type E, ASTM A53/A53M.

B. Fittings:

1. 2 Inches and Smaller: 150-pound banded malleable iron, screwed, ASME B16.3.

2. 2½ Inches and Larger: 150-pound banded malleable iron, screwed, ASME B16.3, or Schedule 40 wrought steel butt-weld fittings, ASME B16.9.

C. Valves: Shutoff valves shall be constructed of materials compatible with the piping. Shutoff valves installed in a portion of a piping system operating above 0.5 psig shall comply with ASME B16.33. Shutoff valves installed in a portion of a piping system operating at 0.5 psig or less shall comply with ANSI Z21.15 or ASME B16.33.

1. Plug:

    a. 1½ Inches and Smaller: Brass standard cock, square head with top check, A.Y. McDonald Series 10554.

    b. 2 Inches and Greater: Iron body, flanged ends, lubricated plug, 150 psi CWP, Flowserve Nordstrom Fig. 115, or 143.

2. Ball:

    a. 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 or equivalent.

    b. Appliance equipment applications, systems operating at less than 0.5 psig: Forged brass body, viton o-rings, PTFE seats, valve certified to 2 psig. Nibco model no. GB-1 or equivalent.

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, certified for indoor and outdoor use. Brasscraft or equivalent

2.04 MATERIALS FOR COMPRESSED AIR SYSTEMS (200 psig and under)

A. Reference Section 15K-S.

2.06 MATERIALS FOR VACUUM SYSTEMS

A. Reference Section 11012S for MicroFab House Cleaning Vacuum and Section 15461S for MicroFab Plant Vacuum system requirements.

2.07 EQUIPMENT

A. General: Equipment required for installation on this contract shall be as specified on the applicable contract drawings and shall 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 with a specified Maximum Allowable Working Pressure (MAWP) of 15 pounds per square inch or greater furnished under this contract will be stamped with an ASME Code Section VIII Unfired Pressure Vessel (“U”) Symbol and a National Board of Boiler and Pressure Vessel Inspector’s number. This will certify 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) will be filed with the National Board in Columbus, Ohio. Two copies of these data reports shall be submitted to Sandia National Laboratories. Testing, certification, and registration will be at the expense of the Contractor. ASTM A-515 and ASME SA-515 type steels shall not be used in the fabrication of pressure vessels.

2. Receiver shall be equipped with shut-off valve, ASME-stamped pressure relief valve, automatic drain valve, manual-bypass drain valve, pressure gauge with valve, pressure switch, and any other appurtenances required for satisfactory operation. Size and capacity shall be as listed on the drawings.

C. Pressure Relief Valves: Valves shall be ASME National Board certified, registered and stamped. The valves shall be factory set to the pressures as specified on the drawings.

D. Thermowells: Reference Section 15123S.

E. Pressure Gauges: Reference Section 15123S.

F. Automatic Air Vents: Air vents shall be B&G Model 87 with brass bodies, all non-ferrous internals and 150 psi maximum operating pressure. Vents shall be capable of accepting ¼" O.D. copper tubing.

PART 3 - EXECUTION

3.01 PIPING INSTALLATION

A. General: Piping installation shall 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 shall govern. Installed piping shall not interfere with the operation or accessibility of doors or windows; shall not encroach on aisles, passageways, and equipment; and shall not interfere with the servicing or maintenance of equipment. Pipe shall be cut accurately to measurements established at the construction site and shall 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 shall have burrs removed by reaming and shall be so installed as to permit free expansion and contraction without damage to joints or hangers. Aboveground piping shall be run parallel with the lines of the building unless otherwise noted on the drawings. Unless otherwise shown on the drawings, horizontal piping shall pitch down in the direction of flow with a grade of not less

than 1 inch in 40 feet. Service pipe, valves, and fittings shall 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. For seismic bracing of piping refer to Sandia Special Specification Section 13085S, "Seismic Protection."

B. Reducers: Reduction in pipe sizes shall be made with one-piece reducing fittings. Forged bushings will be acceptable ONLY with the Sandia Delegated Representative (SDR) approval and when there is no room for reducing couplings and the reduction is less than two pipe sizes. Bushings shall not be used for fuel gas service. Cast bushings ARE NOT acceptable.

C. Unions: All piping unions shall 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 shall be the same as the fittings used in the lines with the unions.

1. Dielectric unions shall be used to connect dissimilar metals (such as steel to copper) to prevent electrolytic action.

D. Installation of Valves: Valves shall be installed at the locations shown on the drawings and where specified. All valves shall be installed with their stems horizontal or above and with sufficient clearance to allow the inspection and repair of two-piece and three-piece valves in place. All screwed valves shall be installed with a down stream union.

Valves in pipelines with a centerline elevation of 7'-0" or greater above floor shall be provided with chainwheel operators and chain to within 3'-0" of floor. Locate such valves where hanging chain will be accessible and will not interfere with aisles or other clearances. Provide chain tie-off on column steel or structure.

E. Hangers and Anchors:

1. All piping shall be rigidly supported from the building structure by means of adjustable ring-type hangers. Welded attachments to the building structure must be approved by the structural engineer. Where pipes run side by side, support on rod and angle iron or Unistrut trapeze hangers. Maximum hanger spacing shall be as follows:

a. Horizontal:

Steel Piping	Maximum Spacing
⅜" and smaller	4'-0"
½" through 1"	7'-0"
1¼" and larger	12'-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 shall be supported in accordance with table 308.5 of the International Mechanical Code.

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

- All Other Piping Materials: Pipes shall be supported in accordance with table 308.5 of the International Mechanical Code.

2. Round rods supporting the pipe hangers shall be of the following dimensions:

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 shall be a minimum of ⅜" and shall 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 will not be permitted.

4. Hanger rods shall 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. Hanger rods shall have minimum 6" threaded ends.

   b. All hanger rod connections shall use double nut fastening.

5. Hanger rods shall be installed vertically. No offset in hanger rod will be permitted.

6. Place a hanger within 1'-0" of each horizontal elbow.

7. Use hangers that are vertically adjustable 1½" minimum after piping is erected.

8. Use copper straps on copper pipe and ferrous hangers on ferrous pipe.

9. Soft copper tubing, where permitted, shall be fastened to the building structure with Unistrut type clamps and spaced not more than 4'-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 upper hanger attachment to steel shall only be installed with retaining clip.

F. Piping Equipment Supports and Fastenings: Fixtures and equipment shall be solidly supported and securely fastened. Installation shall include suitable backing to anchor all hanging fixtures and equipment.

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

1. Manual: A shutoff valve shall be installed ahead of each manual air vent. Where air vent locations are 12'-0" or more above the floor, ¼" O.D. copper tubing shall be installed at the point of venting and extended down with the needle valve installed at an accessible position. All vents that would become inaccessible after the completion of construction shall be extended to an accessible location.

2. Automatic Air Vents: A manual shutoff valve shall 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. Do not install automatic vent valves in the glycol system.

3. Each branch and main system high point shall be vented with a manual vent, after installation, as required to permit removal of all air from the system.

H. Equipment Connections: All piping connections to pumps and other equipment shall be installed without strain at the pipe connection of the equipment. The Contractor shall be required as directed by the Sandia Delegated Representative (SDR) to remove the bolts in flanged connections or disconnect piping to demonstrate that the piping has been so connected. Pipe connections to equipment shall be made with unions or flanged fittings.

I. Joints:

1. Flanged Joints: All flanged joints shall be face matched. Raised face flanges shall not be mated to flat-faced cast-iron flanges on valves or equipment. The raised face must be machined flush. All flange boltholes shall straddle the horizontal and vertical centerlines unless otherwise noted. Bolting shall comply with ASME B31.1, Power Piping. Torque values and tightening sequence for bolts shall be in accordance with gasket manufacturer's instructions.

2. Screwed Joints: Screwed pipe joints shall have American Standard Taper Pipe Threads complying with ASME B1.2. Care shall be taken that the inside of pipe is thoroughly clean and free of cutting oil and foreign matter before installation. Metal screwed pipe joints shall be made leak-tight by the use of Teflon tape, pipe thread lubricant, or Teflon tape and a pipe-lubricating compound.

3. Solder-Joints: Tubing shall be cut square, reamed, and burrs removed. Both the inside of fittings and the outside of tubing shall be well cleaned with sand cloth or wire brush before sweating. Care shall be taken to prevent annealing of fittings and hard drawn tubing when making connections. Joints for sweated fittings on low-pressure piping (150-psig and below) shall be made with a non-corrosive paste flux and solid wire solder composed of 95% tin and 5% antimony, 96% tin and 4% silver, or similar solder of equal characteristics. Solders containing lead or cored solder are not permitted. Joints shall conform to ASTM B828. Joints shall comply with ASME B31.3, Process Piping and the Copper Development Association.

   a. Solder containing antimony SHALL NOT be used to join metals containing zinc (e.g., 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 non-corrosive paste flux and solid wire solder suitable for the service temperatures and pressures expected.

4. Brazed Joints: New copper systems shall be installed with socket type fittings and with an argon or nitrogen purge applied. Flux shall not be used except where joining specialty items and fittings that are not available in copper. Brazing filler metals shall comply with AWS A5.8, Specification for Brazing Filler Metals. Copper-to-copper joints shall be brazed using a copper-phosphorus or copper-phosphorous-silver brazing filler metal (BCuP) without flux. Dissimilar metals, such as copper and bronze or brass, shall be brazed using an appropriate flux with a silver (BAg series) brazing filer metal. The following procedure shall be followed:

a. Tube ends shall be cut square using a sharp tubing cutter. The wheel shall be free from grease, oil, or dirt. The cut end of the tubing shall 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 shall be mechanically cleaned. Joints shall be re-cleaned if they become contaminated prior to brazing. Joints shall be brazed within 1 hour of being cleaned.

c. Where dissimilar metals, such as copper and bronze or brass, are being brazed, flux shall be applied sparingly to minimize contamination of the inside of the tube with flux. Where possible, short sections of copper tube shall be brazed to the non-copper components, and the interior of the subassembly shall 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 shall 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 shall be maintained until the joint is cool to the touch.

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

e. During and after installation, openings in the piping system shall 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 shall begin at the purge port area and continue through the system. The purge connection shall not be changed. While brazing, a discharge opening shall be provided on the opposite side of the joint from where the purge gas is introduced. During brazing, the purge gas flow rate shall be maintained at a level that will not produce a positive pressure in the piping system. While welding, the minimum purge rate shall be 15 scfh for ¼" tubing or 25 scfh for all tubing ⅜" and larger. Purge shall continue after completion of braze until the joint is cool.

f. After brazing, the outside of all joints shall 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 shall 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 shall conform to AWS B2.1-8-005. All pipe surfaces shall be thoroughly cleaned before welding. Each joint, except socket-weld joints, shall be beveled before being welded. The contractor shall provide a non-flammable mat or blanket to protect the structure and adequate fire protection equipment at all locations where welding is done. All elbows shall 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 shall be used. The use of fittings formed from welded pipe sections will not be permitted. All welding shall conform to the requirements of Sandia Special Specification Section 15050, Basic Mechanical Materials and Methods. Any welding work being done requires:

   a. A hot works 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.

J. System Drains: Drains indicated on the drawings in connection with water distribution systems shall be no smaller than ¾" IPS. Install valve with bronze caps or plugs, unless otherwise noted. Additional drains shall be installed at low points on the hot water and chilled water piping to ensure proper draining of the system, and all piping shall pitch to the drains, unless otherwise agreed to by the SDR. Ball or gate valves with hose end fitting and cap shall be provided as drain valves at low points.

K. Discharge from pressure relief valves shall be piped full-size and extended to the outside of the building structure, unless otherwise shown on the drawings.

L. Insulation of all pipes, valves, fittings, and equipment shall be in accordance with Sandia Special Specification Section 15250S, Pipe and Equipment Insulation and Accessories, unless noted otherwise on the drawings.

M. Identification and Labels: All piping systems shall be labeled and identified in accordance with Sandia Special Specification Section 15075S, Mechanical Identification.

N. Cross-Connection Prevention:

1. A backflow prevention assembly (BFP) shall be installed to prevent cross-connection contamination between potable water systems and non-potable, 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, shall be protected by an approved (SDR or IAPMO) vacuum breaker device.

3. Backflow prevention (BFP) assemblies shall be approved by the Foundation for Cross Connection Control and Hydraulic Research, University of Southern California (USC-FCCCHR) and IAPMO.

4. Backflow prevention assemblies used or installed under this contract shall 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 (SDR specified or USC-FCCCHR or Colorado Environmental Training Center, Golden, Colorado) training course.

5. The Contractor shall perform an operational test on any new or relocated backflow prevention assemblies used or installed under this contract. Passing backflow preventers shall be labeled with a tag indicating the test performed, the tester's initials, and the date. Testing documentation shall be submitted to the Sandia Delegated Representative (SDR).

6. Repairs to BFPs shall be made with original manufacturer's parts.

7. Piping downstream of BFPs shall be labeled non-potable or NPW in accordance with Sandia Construction Standard Specification Section 15050, Basic Mechanical Materials and Methods.

O. Compressed Air Receivers: Install receiver with sufficient clearance to allow access to manhole or armhole.

P. Instrumentation: Local temperature and pressure instrumentation located in mechanical equipment rooms shall 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 dial shall be used for ease of reading. Local instrumentation installed on point-of-use equipment shall be of a commercial utility quality, and should be easily read from a vantage point near the equipment.

3.02 TESTS

A. General:

Before insulation is applied, all piping, equipment, and accessories installed under this contract shall be inspected and pressure tested by the Contractor in the presence of the Sandia Delegated Representative (SDR) and approved before acceptance. The Contractor shall furnish all labor, material, and equipment required for testing. The use of data logging instrumentation is recommended for testing. The Contractor shall be responsible for all repairs and retesting as required. All instruments and other equipment whose safe pressure range is below that of the test pressure shall be removed from the line or blanked off before applying the tests.

1. For test, the contractor shall provide a calibrated 4 inch diameter pressure guage of maximum 1% full scale accuracy, maximum 300 PSIG range (100 PSIG for LPS & natural gas) and maximum 2 PSIG graduations.

B. Testing:

1. Steam, condensate, hot water, chilled water, process water, and tower water piping shall be tested hydrostatically at the test pressures specified and shall show no drop in pressure in a 2-hour period.

2. Natural gas, compressed air, and vacuum piping shall be tested using compressed air or dry nitrogen as indicated at the test pressures specified and shall show no drop in pressure in a 2-hour period; gas leaks shall be located by soap testing.

C. Test Pressures:

Unless otherwise specified or noted below, hydrostatic test pressure shall be 1.5 times the system operating pressure and pneumatic test pressure shall be 1.25 times the system operating pressure, whichever is greater.

	TEST PRESSURE (psig)	
SYSTEM	Hydrostatic	Pneumatic
Steam System (125 psig)	225	--
Steam System (30 psig & less)	50	--
Condensate System	100	--
Space Heating Water, Chilled Water, Process Water, and Tower Water System	100	--
Natural Gas System	--	25
Compressed Air System (greater than 60 psig)	--	250
Vacuum System	--	100

D. Flushing and Cleaning:

Coordination for flushing and cleaning of the systems shall be through the SDR to ensure that all systems, components, and controls are in place to execute this procedure. Upon final acceptance for leak tests, all lines shall be blown free of all loose dirt and foreign particles. The lines shall then be thoroughly flushed with water (liquid lines only) or compressed air (for gas lines) at a sufficient flow rate and period of time to ensure complete flushing on the line of all dirt, scale, and foreign matter. Cleaning of the lines shall done with an approved cleaning agent added to the system and circulated throughout the entire system for a period of 4 to 8 hours. The solution shall be fully drained and flushed to rid the system of debris and the cleaning agent. After testing and flushing lines, all filters and strainers shall be cleaned. Immediately after cleaning, the system shall be filled with fresh water and charged with water treatment chemicals. Piping systems shall not remain full of raw water for any length of time without acceptance from the SDR.

END OF SECTION