
SECTION 226100 – LABORATORY GAS & RO/DI PIPING SYSTEMS AND SPECIALITIES

Latest Update: 09-09-2021 See Underlined Text for Edits.

(Engineer shall edit specifications and blue text in header to meet project requirements. This includes but is not limited to updating Equipment and/or Material Model Numbers indicated in the specifications and adding any additional specifications that may be required by the project. Also turn off all “Underlines”.)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 22.

1.2 SUMMARY

- A. Section Includes the requirements for laboratory gas and RO/DI piping systems and specialties using the following: <Edit for particular project>
 - 1. Laboratory gas piping systems, air, vacuum, natural gas
 - 2. Laboratory specialty gas piping systems oxygen, nitrogen, nitrous oxide, carbon dioxide
 - 3. Laboratory air, vacuum, and natural gas outlets
 - 4. RO/DI water piping system
 - 5. General requirements for piping
 - 6. Copper miscellaneous fittings
 - 7. Stainless steel miscellaneous fittings

1.3 PERFORMANCE REQUIREMENTS

- A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.

1.4 ACTION SUBMITTALS

- A. Product Data: For each specified product, include manufacturers cut sheets, dimensional data, performance data, installation instructions, wirings diagrams, power requirements, specified options, and warranty information.

1.5 INFORMATIONAL SUBMITTALS

- A. Brazing certificates.
- B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: Include a copy of each approved submittal along with any applicable maintenance data in the project operation and maintenance manual.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: The installer shall be a qualified licensed installer within the jurisdiction and familiar with the installation of the pipe and fittings specified herein for each piping system.
- B. Compliance: Natural gas piping and components shall comply with NFPA 54.
- C. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications"; or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."
- D. Source Limitations: Obtain pipe and fittings from the same manufacturer for each pipe system.

1.8 WARRANTY/GUARANTEE

- A. See Division 22, Specification Section "Basic Mechanical Requirements – Plumbing" for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENTS

- A. Material Design and Selection: Laboratory System pipes, fittings, and specialties shall be designed and selected, for the intended use, in accordance with the sizes on the drawings and the requirements of this specification.
- B. Acceptable Manufacturers: Acceptable manufacturers shall be one (1) of the following:
 - 1. Laboratory Gas Copper Tube Piping Systems:
 - a. Color Markings: Include standard color marking "OXY," "OXY/ACR," or in green for Type K tube and blue for Type L tube.
 - b. Brazed Solder Joint Copper Tube and Fittings: All copper tube and/or fittings for solder joint application shall be by one manufacturer.
 - 1) Mueller Industries
 - c. Press Type Copper Piping Systems: The basic of design is Viega ProPress copper piping system. Other acceptable manufacturers are:

- 1) Elkhart Products Corporation.
2. Laboratory Natural Gas Steel Piping System:
 - a. Wheatland Tube.
3. RO/DI Water Piping System:
 - a. Spears.
 - b. IPex.
 - c. Viega.

2.2 LABORATORY PIPE MATERIAL APPLICATION

- A. General Application: All pipe, fittings and joint methods shall be as specified below. For this application, Laboratory Piping Systems are defined as follows:
1. Laboratory Gas Piping Systems: Includes compressed air, vacuum, and natural gas serving laboratory areas of the building or project area.
 2. Laboratory Specialty Gas Piping Systems: Includes carbon dioxide, nitrogen, nitrous oxide, and oxygen serving laboratory areas of the building or project area.
 3. RO/DI Water Piping System: Includes RO/DI piping serving laboratory areas of the building or project area.
- B. Laboratory Pipe Material Application Schedule:

| Pipe System | Pipe Material | Fitting Material | Joint Method |
|--|--|--|---|
| Laboratory Natural Gas Systems within the building | Steel Pipe: 1/2 inch to 3 inch: ASTM A53, Grade B, Schedule 40, black steel pipe | 1/2 inch to 3 inch: Malleable Iron Threaded Fittings: ANSI B 16.3, Class 150. Threads per ANSI b.1.20.1 and thread-o-lets. | Threaded: American Standard for Pipe Threads ANSI B2.1 |
| | | 1/2 inch to 3 inch Viega Mega Press G Carbon Steel Fittings with HNBR seals. (Contractor Option) | Press connection with HNBR sealing element. (Contractor Option) |

- C. Natural Gas Piping System (NGPS) in HSF-3: The existing NGPS in HSF-3 is a Viega Copper ProPress G Piping System which is no longer available from Viega. All new piping must comply with the application schedule above and paragraph 2.3 below.

| Pipe System | Pipe Material | Fitting Material | Joint Method |
|---|---|--|--|
| Laboratory Gas: Compressed Air and Vacuum Systems within the building | Copper Tube: 1/2 inch and Larger: ASTM B280, 'ACR' Type 'L', Seamless, hard drawn soft annealed seamless, factory cleaned and capped prior to shipping. | <u>1/2 inch and Larger</u> , Copper Tube Fittings: ASTM B16.22, wrought copper or copper alloy solder joint, 150 lb. | Brazed: AWS A5.8, Classification BCuP-3 (Silver) filler material. |
| | Copper Tube: 1/2 inch to 2 inch: ASTM B88, Type 'L', Seamless, Water Tube, hard drawn temper. | <u>1/2 inch to 2 inch</u> : Viega ProPress copper fittings with EPDM seals. (Contractor Option) | Press connection with EPDM sealing element. (Contractor Option) |
| Laboratory Specialty Gas: Oxygen, Nitrogen, Nitrous Oxide, Carbon Dioxide within the building | Copper Tube: 1/2 inch and Larger: ASTM B280, 'ACR' Type 'L', Seamless, hard drawn soft annealed seamless, factory cleaned and capped prior to shipping. | <u>1/2 inch and Larger</u> : ANSI B16.22 wrought copper fittings. | Brazed: AWS A5.8, Classification BCuP-3 (Silver) filler material. |
| | Copper Tube: 1/2 inch to 2 inch: ASTM B88, Type 'L', Seamless, Water Tube, hard drawn temper. Contractor Option | <u>1/2 inch to 2 inch</u> : Viega ProPress copper fittings with EPDM seals. (Contractor Option) | Press connection with EPDM sealing element. (Contractor Option) |

D. RO/DI Pipe Material Application Schedule:

| Pipe System | Pipe Material | Fitting Material | Joint Method |
|----------------------------------|---|---|--|
| RO/DI System within the building | 1/2 inch to 2 inch: Spears LXT Schedule 80 PVC pipe, conforming to ASTM D1785. Piping shall be pre-cleaned with ends sealed | 1/2 inch to 2 inch: Spears LXT Schedule 80 PVC fittings conforming to ASTM D2467. Pipe fittings shall be pre-cleaned with ends sealed | Socket joint method utilizing the Spears one step solvent Cement system. |
| | 1/2 inch to 2 inch: Viega Type 316 Stainless Steel Pipe and Fittings conforming with ASTM A312, & ASTM A554 requirements. (Contractor Option) | 1/2 inch to 2 inch: Viega ProPress stainless steel fittings with EPDM seals. (Contractor Option) | Press connection with EPDM sealing element. (Contractor Option) |

2.3 COPPER MISCELLANEOUS FITTINGS

- A. Flanges in "Bronze Flanges" Paragraph below are available in NPS 1/2 to NPS 12.
- B. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- C. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150.
 - 1. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, one eight (1/8) inch maximum thickness, full-face type.
 - 2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.
- D. Copper Unions: ASME B16.22 or MSS SP-123, wrought-copper or cast-copper alloy.
- E. Copper Unions:
 - 1. MSS SP-123.
 - 2. Cast-copper-alloy, hexagonal-stock body.
 - 3. Ball-and-socket, metal-to-metal seating surfaces.
 - 4. Solder-joint or threaded ends. Fittings in "Copper Pressure-Seal-Joint Fittings" Paragraph below are available in NPS 1/2 to NPS 4.

- F. Natural Gas Piping System (NGPS) in HSF-3: Provide the following fittings for new connections to existing piping:
1. Piping Two (2) Inch and Smaller: Provide a Viega Copper Adapter Model 2911.1ZL with a male thread end and a solder end.
 2. Piping Two and One Half (2) Inch and Larger: Provide flanged connections with a solder end connection and a threaded end or plain connection and approved gasket material for natural gas service.
 3. See Execution Part 3 for installation requirements.

2.4 STEEL MISCELLANEOUS FITTINGS

- A. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in "Piping Applications" Article.
- B. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in "Piping Applications" Article.
- C. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
1. Material Group: 1.1.
 2. End Connections: Butt welding.
 3. Facings: Raised face.
- D. Steel Pressure-Seal Fittings:
1. Manufacturers: Subject to compliance with requirements, provide products by the following: <Insert three manufacturers>.
 2. Housing: Steel.
 3. O-Rings and Pipe Stop: EPDM.
 4. Tools: Manufacturer's special tool.
 5. Minimum 300-psig working-pressure rating at 230°F.
- E. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.5 LABORATORY GAS PIPING SYSTEMS AIR, NITROGEN, OXYGEN, CARBON MONOXIDE, ARGON, AND VACUUM VALVES:

- A. See Division 22 Specification Section "Valves for Plumbing Piping Systems" for required valves

2.6 LABORATORY NATURAL GAS PIPING SYSTEM VALVES:

- A. See Division 22 Specification Section “Valves for Plumbing Piping Systems” for required valves.

2.7 RO/DI WATER PIPING SYSTEM VALVES:

- A. See Division 22 Specification Section “Valves for Plumbing Piping Systems” for required valves.

2.8 LABORATORY NATURAL GAS, COMPRESSED AIR AND VACUUM OUTLETS

- A. Provide laboratory air, natural gas, and vacuum outlets where indicated on the drawings, details and elevations and as specified. The basis of design is T & S Brass.
- B. Tapered Turret Type: Provide tapered turret with ground key hose cock with integral tapered serrated hose tip. The key lock shall be all brass, polished chromium plated finish, plastic color coded index, plastic mounting gasket, supply nipple, & lock nut for deck mounting as follows:
 - 1. Single Outlet Type: T&S Model BL-4200-1 for natural gas, compressed air and vacuum service.
 - 2. Double Outlet Type (90° Outlets): T&S Model BL-4200-02 for natural gas, compressed air and vacuum service.
 - 3. Double Outlet Type (180° Outlets): T&S Model BL-4200-02 for natural gas, compressed air, and vacuum service.
- C. Ground Key Type: Provide ground key hose cock with integral tapered serrated hose tip. All brass polished chromium plated finish, plastic color coded index, three eighths (3/8) inch male inlet, & suitable for installation on exposed wall mounted piping as follows:
 - 1. Single Outlet Type: T&S Model BL-4000-1 for natural gas, compressed air, vacuum service.
- D. Panel Flange Type: Provide panel flange with ground key hose cock with integral tapered serrated hose tip. The key lock shall be all brass, polished chromium plated finish, plastic color coded index, plastic mounting gasket, for surface mounting as follows:
 - 1. Single Outlet Type: T&S Model BL-4250-01 for natural gas, compressed air and vacuum service.
 - 2. Double Outlet Type: T&S Model BL-4250-02 for natural gas, compressed air and vacuum service.

2.9 LABORATORY SPECIALTY GAS OUTLETS <Delete if not required>

- A. Provide needle valve hose cock with chrome plated brass body and handle, serrated tip outlet, special valve packing for specialty gases (N₂/O₂) and three eighths (3/8) inch NPT male inlet.
 - 1. Outlet Type: T & S Model BL - 4010-01 for Nitrogen (N₂) and/or Oxygen (O₂).

2.10 LABORATORY GAS ZONE VALVE BOX

- A. Provide A laboratory gas zone valve box assembly where indicated on the drawings and details. Each valve box shall be model V-BOX-ZVBA-E-01 recessed type box and include a steel box with a front aluminum frame with a clear window as manufactured by AMICO Labs or approved equal. Each box assembly shall be twelve (12) inches wide x four (4) inches deep x ten and one half ((10-1/2) inches high with a twelve and three sixteenth (12-3/16) inch high x thirteen and eleven sixteenth (13-11/16) inch wide front frame.
- B. The valve box assembly shall be constructed of eighteen (18) gauge steel with two (2) knockout holes on each side for piping, and two (2) adjustable steel mounting brackets. Valve box shall come with a white baked on enamel finish.
- C. Front frame assembly shall be constructed of anodized aluminum and mounted on the box by #6 – 3/8 tapping screws, and a removable clear window with a pullout ring.

2.11 MANUAL LABORATORY BOTTLED GAS MANIFOLDS <Coordinate with UMB and Delete if not required>

- A. Carbon Dioxide (CO₂): Provide manual type manifolds for each new group of CO₂ cylinders where indicated on the drawings and details. The manual type manifolds shall be as manufactured by AIRGAS for the following arrangements: <Edit For Project Requirements>
 - 1. Two (2) Cylinders: Model Y11 CP720B320, with two (2) thirty six (36) inch long stainless steel pigtail connections with check valves
 - 2. Four (4) Cylinders: Model Y11 CP740B320 with four (4) thirty six (36) inch long stainless steel pigtail connections with check valves
 - 3. Six (6) Cylinders: Model Y11 CP760B320 with six (6) thirty six (36) inch long stainless steel pigtail connections with check valves.
- B. Nitrogen (N₂): Provide manual type manifolds for each new group of N₂ cylinders where indicated on the drawings and details. The manual type manifolds shall be as manufactured by AIRGAS for the following arrangements: <Edit For Project Requirements >

1. Two (2) Cylinders: Model Y11 CP720B580, with two (2) thirty six (36) inch long stainless steel pigtail connections with check valves
 2. Four (4) Cylinders: Model Y11 CP740B580 with four (4) thirty six (36) inch long stainless steel pigtail connections with check valves
 3. Six (6) Cylinders: Model Y11 CP760B580 with six (6) thirty six (36) inch long stainless steel pigtail connections with check valves.
- C. Oxygen (O₂): Provide manual type manifolds for each new group of O₂ cylinders where indicated on the drawings and details. The manual type manifolds shall be as manufactured by AIRGAS for the following arrangements: **<Edit For Project Requirements >**
1. Two (2) Cylinders: Model Y11 CP720B540, with two (2) thirty six (36) inch long stainless steel pigtail connections with check valves
 2. Four (4) Cylinders: Model Y11 CP740B540 with four (4) thirty six (36) inch long stainless steel pigtail connections with check valves
 3. Six (6) Cylinders: Model Y11 CP760B540 with six (6) thirty six (36) inch long stainless steel pigtail connections with check valves.
- D. The bottled gas cylinders shall be supplied and installed by others.
- E. See Division 22 Specification Section “Valves for Plumbing Piping Systems” for valve requirements.
- 2.12 **AUTOMATIC LABORATORY BOTTLE GAS MANIFOLD SYSTEM** **< Coordinate with UMB and Delete if not required >**
- A. Bottled Gas Manifold: Where indicated on the drawings provide bottled gas manifold system shall be Beacon Medæ Model Number 6-107120-2 wall mounted lifeline automatic switchover manifold, or approved equal. The manifold shall accommodate multiple cylinders equally divided into two (2) banks for carbon dioxide gas service at 55 psi delivery pressure. The cylinder banks are arranged in a staggered configuration and provide an uninterrupted supply of gas for the specific gas application. The manifold is cleaned, tested, and prepared for the indicated gas service and constructed in accordance with requirements of the latest edition of NFPA 99 and CGA. The manifold components shall be designed to operate over a temperature range of 32°F through 130°F.
 - B. Manifold Design and Operation: The manifold design shall include bank regulator, one for each cylinder bank, to initially reduce the cylinder pressure to the two (2) line regulators, which control the final line pressure. Both line pressure regulators are in service at all times to maximize flow rates. The manifold operation automatically changes from the depleted primary supply bank to the secondary supply bank without fluctuation in line pressure utilizing dome-bias loading and unloading of the bank regulators. After replacement of the depleted cylinders, the manifold automatically indicates the cylinder bank recently replaced as the secondary supply. Manual resetting of the control panel is not necessary. The manifold includes a line pressure gauge, two (2)

cylinder bank pressure gauges (left bank and right bank), and color-coded indicator LED visual indicators for “IN USE” (green), “READY” (yellow), and “EMPTY” (red) for each cylinder bank. The manifold has intermediate and line pressure relief valves that are internally connected to a common vent port, terminating into a one half (1/2) inch FNPT O-ring sealed “zero clearance” union. Master shutoff valves (one for each cylinder bank) are located within the manifold cabinet and both valves are fabricated with metallic seating surfaces. The manifold is designed for placement of four “H” cylinders directly underneath the manifold cabinet. The cabinet enclosure is easily removable by releasing draw latches for component accessibility and the enclosure may be secured from unauthorized access by locking the draw latches (locks provided by others).

- C. **Manifold Accessories:** The manifold accessories shall include high-pressure modular header assemblies with gas specific pigtail-to-header check valves to permit changing of cylinders without gas leakage. Stainless steel flexible pigtails are provided for each cylinder gas connection. A separate power supply is furnished with the manifold to convert 120 VAC to 24 VAC output power and includes dry contacts for two (2) separate, electrically isolated, remote alarm connections. The power supply is housed in a NEMA 3R enclosure with electrical requirements of one (1) amp at 120 VAC, 60Hz, single phase. The manifold is supplied with a three quarter (3/4) inch FNPT O-ring sealed “zero clearance” union outlet. The system also includes a three quarter (3/4) inch full port, three piece, ball-type source shut-off valve with a one eighth (1/8) inch FNPT port. The source valve has a three quarter (3/4) inch NPT attachment to the union outlet and a three quarter (3/4) inch nominal copper (type k) tube for brazing to main supply line.
- D. **Submittal Data:** The submittal date shall include the manifold control panel, wall mounting bracket, pressure gauges, stainless steel pig tail cylinder connections, regulator assemblies, pressure switches, manifold piping and wall brackets, source shut off valve, power supply assembly, and installation, operation, and service manual.

2.13 GAS CYLINDER STORAGE RACKS

- A. See Architectural Specification Section “Specialties” for cylinder storage racks.

2.14 NITROGEN

- A. Comply with USP 32 - NF 27 for oil-free dry nitrogen.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of laboratory gas piping. Install laboratory gas piping as indicated unless deviations to layout are approved on coordination drawings.

- B. Install laboratory gas piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- C. Install laboratory gas piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install laboratory gas piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
- E. Install piping adjacent to equipment and specialties to allow service and maintenance.
- F. Install nipples, unions, special fittings, and valves with pressure ratings same as or higher than system pressure rating. Install laboratory gas piping to permit valve servicing.
- G. Install laboratory gas piping free of sags and bends.
- H. Install fittings for changes in direction and for branch connections.
- I. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Specification Section "Sleeves, Sleeve Seals and Escutcheons for Plumbing Piping."
- J. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Specification Section "Sleeves, Sleeve Seals and Escutcheons for Plumbing Piping."
- K. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Specification Section "Sleeves, Sleeve Seals and Escutcheons for Plumbing Piping."

3.2 PIPING INSTALLATION SPECIFIC TO LABORATORY COMPRESSED AIR

- A. Install all horizontal and vertical compressed air piping parallel to the building floors, walls, and partitions.
- B. Install all horizontal compressed air and drain piping with one eighth (1/8) inch per foot slope downward in direction of air flow.
- C. Connect branch air piping to mains from top of main. Provide drain leg and drain trap at end of each main, each branch, and each low point in piping system.
- D. Where piping connects to outlets mounted on casework coordinate the locations of the branch piping and outlets with the casework installer.

- E. System shall be purged with oil free dry nitrogen. A high flow purge shall be performed at each outlet. Each outlet shall flow fully until the purge produces no discoloration in a white cloth.

3.3 PIPE INSTALLATION SPECIFIC TO LABORATORY VACUUM

- A. Install all horizontal and vertical laboratory vacuum piping parallel to the building floors, walls, and partitions.
- B. Connect branch vacuum piping to mains from top of the main.
- C. Where piping connects to outlets mounted on casework coordinate the locations of the branch piping and outlets with the casework installer.
- D. Systems shall be purged with oil free dry nitrogen. A high flow purge shall be performed at each outlet. Each outlet shall flow fully until the purge produces no discoloration in a white cloth.

3.4 PIPE INSTALLATION SPECIFIC TO LABORATORY BOTTLED GASES

- A. Install all horizontal and vertical laboratory bottled gas piping parallel to the building floors, walls, and partitions in accordance with the requirements in NFPA 99, CGA all other applicable codes.
- B. Connect branch bottled gas piping to mains from top of the main.
- C. Install bottled gas manifolds level and plumb, in accordance with manifold manufacturers' written installation instructions, rough in drawings and the requirements in NFPA 99, CGA all other applicable codes.
- D. Where piping connects to outlets mounted on casework coordinate the locations of the branch piping and outlets with the casework installer.
- E. Systems, including the manifold shall be cleaned, tested, and prepared for the indicated gas service and constructed in accordance with requirements of the latest edition of NFPA 99 and CGA.
- F. Keep all manifold parts, tools, and work surfaces free of oil, grease, and dirt. Do not use chemicals, lubricants or sealants unless approved by the manufacturer.

3.5 PIPE INSTALLATIONS SPECIFIC TO NATURAL GAS

- A. Preparation:
 - 1. Precautions: Before turning off the gas to the premises, or section of piping, turn off all equipment valves. Perform a leakage test as required in Division 22

Specification Section "Leak Test Plumbing Piping Systems" to determine that all equipment is turned off in the piping section to be affected.

2. Conform with the requirements in NFPA 54, for the prevention of accidental ignition.

B. Laboratory Natural Gas Piping:

1. General: Conform to the requirements of NFPA 54 - National Fuel Gas Code.
2. Concealed Locations: Except as specified below, install concealed gas piping in an air-tight conduit constructed of Schedule 40, seamless black steel with welded joints. Vent conduit to the outside and terminate with a screened vent cap.
 - a. Above Ceiling Locations: Gas piping may be installed in accessible above ceiling spaces (subject to the approval of the authority having jurisdiction), whether or not such spaces are used as a plenum.
 - 1) Valves shall not be located in ceiling plenums.
 - 2) Piping installed in plenums shall be welded.
 - b. Piping in Walls or Partitions: Concealed piping shall not be located in solid walls or partitions. Tubing shall not be run inside hollow walls or partitions unless protected against physical damage. This does not apply to tubing passing through walls or partitions.
 - c. Prohibited Locations: Do not install gas piping in or through a circulating air duct, clothes chute, chimney or gas vent, ventilating duct, dumb waiter, elevator shaft, in floor construction, and below floor slabs. This does not apply to accessible above ceiling space specified above.
3. Drips Legs: Install a drip leg at points where condensate may collect, at the outlet of the natural gas meter, and in a location readily accessible to permit cleaning and emptying. Do not install drips where condensate is likely to freeze.
 - a. Construct drips and sediment traps using a tee fitting with the bottom outlet plugged or capped. Use a minimum of three (3) pipe diameters in length for the drip leg. Use same size pipe for drip leg as the connected pipe.
4. Install natural gas piping at a uniform grade of one quarter (1/4) inch in fifteen (15) feet, upward in direction of the risers.
5. Connect branch outlet pipes from the top or sides of horizontal lines, not from the bottom.
6. Pipe Joint Construction:

- a. Threaded Joints: Refer to NFPA 54, for guide for number and length of threads for field threading steel pipe.
7. Terminal Equipment Connections:
 - a. Install shut-off valve upstream and within six (6) feet of gas appliance. Install a union or flanged connection downstream from the gas cock to permit removal of controls.
 - b. Drip Legs: Install a tee fitting with the bottom outlet plugged or capped as close to the inlet of the gas appliance as practical. Drip leg shall be a minimum of three (3) pipe diameters in length.
 8. Electrical Bonding and Grounding:
 - a. Install above ground portions of gas piping systems, upstream from equipment shutoff valves electrically continuous and bonded to a grounding electrode in accordance with NFPA 70 - "National Electrical Code."
 - b. Do not use gas piping as a grounding electrode.
 - c. Conform to NFPA 70 - "National Electrical Code," for electrical connections between wiring and electrically operated control devices.
 9. Flexible pipe connections shall not be permitted. All connections shall be hard piped.
 10. Natural Gas Piping System (NGPS) in HSF-3: Where parts of the existing NGPS in HSF-3 require new pipe connections comply with the following:
 - a. Piping Two (2) Inch and Smaller: Install a Viega propress adapter with a solder connection on one end and a male threaded connection on the other end.
 - 1) Locate the adapter at least one and one half (1-1/2) pipe diameters away from the nearest pipe coupling and/or fitting.
 - 2) Adapter Solder End: Braze the solder end of the adapter to the NGPS copper pipe in accordance with ANSI LC-4/CSA 6.32.
 - 3) Adapter Threaded End: Provide a short section of black steel pipe with a female thread end on one end and a plan end on the other end. Connect the threaded end to the adapter and connect a carbon steel pipe coupling to the plan end.
 - 4) Prior to brazing the adapter to the copper pipe wrap the nearest coupling and/or fitting with wet towels to prevent damage to the seals.
 - b. Piping Two and One Half (2) Inch and Larger: Install flanged connections to connect new black steel piping to the existing NG copper piping complying with the following:

- 1) Locate the solder end flange connection at least one and one half (1-1/2) pipe diameters away from the nearest pipe coupling and/or fitting.
- 2) Solder End Flange: Braze the solder end of the flange to the NGPS copper pipe in accordance with ANSI LC-4/CSA 6.32.
- 3) Install an approved gasket material for natural gas between the two flanges.
- 4) Threaded End Flange: Bolt to solder end flange and gasket. Connect new piping to thread end.
- 5) Plain End Flange: Bolt to solder end flange and gasket. Connect new piping to plain end with carbon steel fillings. (contractor option)

3.6 LABORATORY GAS ZONE VALVE BOX INSTALLATION

- A. Install laboratory gas zone valve box level and plumb, in accordance with box manufacturers' written installation instructions, and rough in drawings.
- B. Install the ball valve with the valve handle in a horizontal position so the valve is closed the handle is in a vertical position allowing the removable window to be in place.

3.7 LABORATORY BOTTLED GAS MANIFOLD INSTALLATION

- A. Install bottled gas manifolds level and plumb, in accordance with manifold manufacturers' written installation instructions, rough in drawings and the requirements in NFPA 99, CGA all other applicable codes.
- B. The manifold shall be cleaned, tested, and prepared for the indicated gas service and constructed in accordance with requirements of the latest edition of NFPA 99 and CGA.
- C. The cylinder banks are arranged in a staggered configuration and provide an uninterrupted supply of gas for the specific gas application.
- D. Keep all manifold parts, tools, and work surfaces free of oil, grease, and dirt. Do not use chemicals, lubricants or sealants unless approved by the manufacturer.

3.8 JOINT CONSTRUCTION

- A. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
- B. Threaded Joints: Apply appropriate tape to external pipe threads.
- C. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Braze Joints" chapter. Continuously purge joint with oil-free, dry nitrogen during brazing.

3.9 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Division 22 Specification Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.
- B. Comply with requirements in Division 22 Specification Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.

3.10 IDENTIFICATION

- A. Install identifying labels and devices for specialty gas piping, valves, and specialties. Comply with requirements in Division 22 Specification Section "Identification for Plumbing Piping and Equipment."

3.11 PROTECTION

- A. Protect tubing from damage.
- B. Retain sealing plugs in tubing, fittings, and specialties until installation.
- C. Clean tubing not properly sealed, and where sealing is damaged, according to "Preparation" Article.

3.12 DEMONSTRATION

- A. Engage factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain bulk gas storage tanks.

3.13 PIPE INSTALLATIONS SPECIFIC TO RO/DI WATER

- A. Close open ends of piping and equipment when it is not actually being worked on, with flange cover, cap or plug to prevent entry of foreign material during construction. Handle material in such manner as to prevent introduction of contaminant into the piping system.
- B. Where piping will be concealed within partitions, install a seamless one piece pipe without joints. Pipe shall be "L" shape with a minimum eight (8) feet – zero (0) inches long straight leg, unified factory pre-formed ninety (90) degrees bend and twelve (12) inch short straight leg.
- C. Space piping to maintain at least three (3) inch clearance from any other object.
- D. Install piping free of traps and with sufficient slope, one (1) inch in fifty (50) feet – zero (0) inches, so that systems may be drained to one or several points. In the event that it is impossible to drain to a common point due to structural obstructions and finished ceiling heights, provide additional drain valves required to completely drain piping systems. Verify location of drain valves with A/E before installation.

- E. Use of all-thread (close) nipples, swaged nipples and bushing reducers is not acceptable.
 - F. Provide supports for vertical risers minimum three (3) feet- zero (0) inches on center and at every floor.
 - G. Provide supports at each change of direction.
 - H. Make joints between pipe and other materials with polypropylene adaptors manufactured for the specific application. Follow manufacturer's recommendations for joining and installation of plastic pipe.
 - I. Install fittings and valves with strict adherence to the manufacturer's recommendations.
 - J. Flushing:
 - 1. Provide prefilter, carbon filter and exchangeable mixed bed deionizer(s) in order to produce required deionized water. Provide a 0.45 micron filter downstream of deionizer(s).
 - 2. Deionized water used shall have a minimum specific resistance of fifteen (15) megohm-CM at 250°C.
 - 3. Isolate and/or bypass all equipment in system. Do not use system pumps.
 - K. Fill system with deionized water, circulate water with a minimal return quality of fifteen (15) megohm-cm at 250°C for eight (8) hours with UV light and 0.45 micron filter in place, then drain the system including low points. Refill system with deionized water then bleed air from system.
- 3.14 LEAK TEST PIPING SYSTEMS:
- A. See Division 22 Specification Section "Leak Test Plumbing Piping Systems" for testing requirements.

END OF SECTION 226100