

## 22 60 00 – Gas and Vacuum Systems for Laboratory & Healthcare Facilities

### 1. General

#### A. Furnish and test the following systems:

1. Oxygen (O<sub>2</sub>)
2. Vacuum (Vac)
3. Medical/clinical compressed air (MA)
4. Nitrous Oxide (N<sub>2</sub>O)
5. Nitrogen (N<sub>2</sub>)
6. Carbon Dioxide (CO<sub>2</sub>)
7. Evacuation / WAGD / AGE

#### B. Work includes outlets, valve boxes, valves, alarm systems, pressure and vacuum switches and miscellaneous accessories for complete systems.

#### C. Work also includes pressure testing, precertification testing and final testing, including purging and analyzing.

#### D. Work described in this section does not include electrical wiring for alarms and electrical accessories associated with the system.

#### E. All equipment must be supported directly by structural members with adequate load-bearing capacity and material integrity, using appropriate anchoring/connection hardware. Under no circumstances may equipment be supported by connections to finish materials. For example, equipment hung from toggle bolts through plaster-on-lath, gypsum board or ACT ceilings is **not acceptable**.

### 2. Code Compliance / Quality Assurance

#### A. Install in compliance NFPA 99, Chapter 4 as required and enforced by Authority having Jurisdiction (AHJ).

#### B. Comply with local, state and federal codes applicable in this jurisdiction.

#### C. Employ only qualified journeymen for this work. Employ a competent qualified mechanic/piping foreman who has satisfactorily completed at least five other similar installations for this work.

#### D. All medical gas brazers must be certified according to NFPA 99. A copy of the certification must be available upon request.

### 3. Coordination

- A. Coordinate with other trades to assure timely installations and to avoid conflicts and interference.
- B. Work closely with the metal stud partition installer and/or mason to assure that anchors, sleeves and similar items are provided in sufficient time to avoid delays; chases and openings are properly sized and prepared.
- C. Coordinate layout of medical gas systems in all spaces and identify all piping accurately and in accordance with Section 9 of this guideline.

### 4. Qualifications of Manufacturers

#### A. Pipeline System Components:

- 1. One manufacturer shall supply the medical gas piping system equipment to include outlets, valves, manifolds, gauges, valve boxes and alarm boxes.
- 2. Component manufacturer shall have a pipeline system engineer or product specialist available to periodically check with the Contractor during installation of pipeline system equipment and provide a service organization to certify the system.
- 3. Provide ongoing service support to the Owner after acceptance of system.

### 5. Piping Materials

- A. Piping: Seamless Type K (ASTM 88) copper tubing, in accordance with NFPA 99 Chapter 4. Piping shall be precleaned and plugged by supplier before shipment to jobsite. Piping shall be labeled according to NFPA 99.
- B. Fittings: Wrought copper, brass or bronze designed expressly for brazed connection.
- C. Brazing alloy: Melting point of at least 1000°F.
- D. Flux: Do not use for copper-to-copper joints. Use flux for joining copper to brass or bronze. In those cases where flux is used, exercise particular care in applying the flux to avoid leaving any excess inside the completed joints.
- E. Isolation of copper tubing from dissimilar metal shall be accomplished either through use of copper tear drop hangers or plastic isolators. Duct tape shall not be used. Vibration clamps or tube clamps shall be used with Unistruts (with appropriate isolator).
- F. The vacuum piping shall be 3/4 inch ID to the outlet extension.
- G. On-site cleaning: Shall be limited to re-cleaning surfaces in the immediate vicinity of the joints that have become contaminated prior to brazing. Surfaces shall be cleaned by washing in a clean, hot water/alkaline solution, such as sodium carbonate or tri-sodium

phosphate (1 lb to 3 gal of potable water). Interior surfaces shall be thoroughly scrubbed and rinsed with clean, hot, potable water.

1. Any on-site cleaning shall be supervised by DUMC personnel.
2. Clean brushes, rubber gloves, towels and bags shall be used. After rinsing and drying the surfaces, the fittings, valves, etc. shall be placed in a clean bag until installation (to avoid recontamination).

H. Where three (or more) piping systems are run together, Unistruts shall be used to support the pipes. These piping systems shall be spaced appropriately so that valves shall not interfere with or obstruct each other.

## 6. Laboratory Vacuum Systems

- A. Vacuum system including pump and venting must be determined and engineered on a project specific basis.
- B. Provide system traps in each lab
- C. HEPA filtration may be required in some labs utilizing lab vacuum systems

## 7. Medical Gas Outlet Stations

### A. Recessed Wall Outlets:

1. Outlets shall be UL listed and conform to applicable NFPA and CGA Standards. Outlets shall consist of separate rough-in and finish assemblies and be modular in design.
2. The rough-in assembly shall be corrosion resistant with a secondary check valve and a permanent pin-keying system for each specific gas. The copper tubing inlet shall rotate 360 degrees to allow connection from any direction. The assembly shall allow pressure testing without additional labor to remove plug or adapter after testing.
3. The DISS finishing assembly shall be designed in accordance with CGA V-5 Standards for diameter index safety system and containing a primary check a minimum of 2.5 square inches of color coding and incorporate an automatic primary check valve plaster adjustment up to 1/2 inch over standard 1/2 inch wall finish. Quick-release mechanism shall not be incorporated into the outlet. Outlet design shall be such as to insure absolutely no gas flow until the correct adapter is fully engaged. Each assembly shall have a separate cover plate for each gas for ease of service without preventing use of other outlets.
4. Each vacuum outlet shall have an adjacent slide for supporting vacuum bottle assembly. Each vacuum slide shall be ganged together and roughed-in along with the other gases.

B. Other Outlets:

1. All other outlets and/or outlet connections shall be DISS (columns, hose drops, etc.)

8. Medical Gas Valving

A. Main and Base of Riser Valves (valves not in boxes)

1. Valves and tubing shall be specially prepared for oxygen service and shall conform in all particulars to NFPA 99.
2. Valves shall be ball-type with Teflon seats and adjustable stem packing gland with Teflon stem seal, through 2 inches. 2-1/2 to 3 inch valves shall have Teflon seats and double Teflon stem seal. 4 inch valves shall have Buna-N ball seats.
3. Ball valves shall be rated at 400 psig, actuate from full "ON" to full "OFF" by 90 degrees turn of vinyl gripped valve handle. Factory installed copper tubing shall be extended sufficiently to help prevent valve seat damage during soldering.
4. Unless specifically noted or obviously required, main and riser valves located in non-public areas are not required to be installed in box.
5. Quantities and sizes as indicated on drawings.
6. All service (main, riser, and branch) valves shall be lockable (any valves not located within a valve box.)
7. All valves shall be labeled according to NFPA 99.
8. Valves shall be quarter-turn ball type and three-piece design with full size ports.

B. Area/Zone Valves (valves in boxes)

1. Zone valve boxes shall be constructed of extruded aluminum or 18-gauge sheet steel with air-dried lacquer finish. The cover frame shall be made of an anodized aluminum and attached to the box by concealed screws. The finished assembly shall be substantially dust-tight. The frame assembly shall be capable of adjusting for variances in wall thickness up to one inch. The frame assembly shall contain an easily removable cover window with pull ring. The window shall conceal exposed piping and valves within the box and shall be labeled "Caution - Medical Gas Control Valves - Close Only in Emergency". Tinted transparent window shall be provided to display the gas service, the area controlled by the valve, and pressure gauges on units so equipped.
2. Frames for valve boxes shall have uniform width for balanced appearance. Manufacturer shall provide color-coded self-adhesive gas service labels for compliance with NFPA 99 labeling requirements. Apply labels to each valve within

- the assembly or proper gas service identification according to the manufacturer's instructions.
3. Placement of the valve within the zone valve box shall be such that the removable window cannot be replaced when any valve is closed. Factory installed Type K copper pipe extensions shall extend three (3) inches outside the valve box. Design of the valve box shall be such that valves may be removed prior to brazing, without disassembly of the box, to permit field rearrangement of valves if necessary. Valves shall be ball type, cleaned for oxygen service, supplied with capped ends and shall operate full open to closed position with 90 degree handle rotation.
  4. Valve boxes shall include 1-1/2 inch pressure gauges reading 0-100 psig for oxygen, nitrous oxide and air; 0-300 psi for nitrogen and 0-30 inHg for vacuum or evacuation vacuum. The gauge port shall be equipped with removable plug for pressure testing prior to final assembly of gauge. Gases at nonstandard operating pressures shall have gauges that meet the requirements of NFPA 99.
  5. Gauge model zone valve box assemblies shall read pressure downstream (upstream for vacuum) of the valve per NFPA 99.
9. Medical Gas Alarm Systems
- A. Area/Zone Alarm Digital (IASII)
    1. Digital area alarm panels shall be designed to meet the requirements of NFPA and CSA standards. Alarms shall be UL listed as an assembly and shall include all necessary gauges, factory wiring, transformers and circuitry requiring only 120 or 240 volt primary power. Internal voltage shall be stepped down to 12 or 24 volt closed, control circuit power. Wiring to external switches shall also be at the stepped down voltage.
    2. Furnish and install the alarm. Coordinate the power wiring with work by the Electrical Subcontractor.
  - B. Area/Zone Alarms
    1. Digital area alarm panels shall be modular in design and shall consist of a central module which is identical to master alarm central module and of alarm modules which plug into the central module and attach to the wall with two screws. The central module shall operate with up to ten alarm modules.
    2. The alarm modules shall have a digital display of each gas monitored per NFPA 99. Units utilizing a single display for multiple gases are not acceptable.
    3. The signal for alarm modules shall be from pressure sensors installed in the area being monitored. Sensor for master alarm and area alarm shall be identical and shall be installed in gas specific check valves for ease of servicing.

### C. Alarms General

1. Central modules shall be capable of operating with any combination of ten point alarm modules (master alarm) and digital alarm modules (area alarm) so that separate panels are not required.
2. All alarms shall have the capability of communicating over a synapse cable so that when so programmed, hospital personnel may monitor conditions at remote panels.

## 10. Medical Piped Gas Identification

- A. Medical piped gas labels shall contain flow arrows and be color coded according to NFPA. Medical piped gases shall be labeled at 10 foot intervals. Piping shall contain labels before and after all wall penetrations and all piping turns. Piping shall be labeled at least once in each room.

## 11. Medical Piped Gas Installation

- A. Pre-clean and prepare copper pipe, tubing, valves and fittings for medical gas service in accordance with Chapter 4 of NFPA 99, except those supplied especially prepared for such service by the manufacturer and received sealed on the job. Copper tubing shall be pre-cleaned, degreased and delivered sealed to the jobsite.
- B. Joints in the piping, except those at equipment requiring screwed connections, shall be made with silver brazing alloy or similar high melting point (at least 1000°F) brazing metal.
- C. Silver brazing material: Stay-Silv-15, Silvaloy-15, Aircosil No. 15 or Phos-Silver-15.
  1. Silver brazing alloy composition: 15% silver, 80% copper and 5% phosphorus. No cadmium.
  2. Minimum of 1000°F liquid melting point with ASTM rating of "BCuP5".
  3. The use of flux is prohibited for the making of joints between copper-to-copper pipes and fittings. Appropriate flux similar to "Stay-Silv-Black Flux" or "Stay-Silv-White Flux" is required between dissimilar metals such as copper to brass or bronze material, when parts are heated over a prolonged period.
- D. During the brazing of pipe connections, the interior of the pipe shall be purged continuously with oil-free, dry nitrogen. The outside of the tube and fittings shall be cleaned by washing with hot water after assembly.
- E. Threaded joints in piping systems shall be made up with polytetrafluorethylene (such as Teflon) tape or other thread sealants suitable for oxygen service. Apply sealants to the male threads only.

- F. Support piping with pipe straps or hangers at appropriate intervals and do not support from other piping. Piping shall be supported from the building structure. Under no circumstances shall piping or other equipment be suspended from finish materials such as dropped ACT ceilings or plaster lath.
  - 1. Isolate copper piping from dissimilar metals. Duct tape shall not be used as an isolation material.
- G. Threaded joints in distribution piping shall be limited to the connection of gauges, switches and similar devices.
- H. Use flux with a silver (BAg series) brazing filler material. Some flux may contain compounds objectionable for oxygen service and shall not be employed.
- I. Pipe shall be prepared, fit together and brazed within the same 24-hour period to avoid contamination of the pipe. During intervals within the work where work is incomplete, end caps (sized according to pipe) shall be installed over the ends of the pipe and taped to avoid contamination.
- J. Fittings, valves and other components shall remain sealed until installation onto the system. Bags shall remain closed and sealed when not in use.
- K. On-site cleaning: Shall be limited to re-cleaning surfaces in the immediate vicinity of the joints that have become contaminated prior to brazing. Surfaces shall be cleaned by washing in a clean, hot water/alkaline solution, such as sodium carbonate or tri-sodium phosphate (1 lb to 3 gal of potable water). Interior surfaces shall be thoroughly scrubbed and rinsed with clean, hot, potable water.
  - 1. Any on-site cleaning shall be supervised by DUMC personnel.
  - 2. Clean brushes, rubber gloves, towels and bags shall be used. After rinsing and drying the surfaces, the fittings, valves, etc. shall be placed in a clean bag until installation (to avoid recontamination).
- L. After installation of the piping but before installation of the outlet valves, blow lines clear by means of oil-free, dry nitrogen.
- M. Piping exposed to physical damage shall be adequately protected.
- N. While being brazed, joints shall be purged with inert gas (nitrogen NF) per NFPA 99.
- O. Uninstalled piping shall be kept on a pipe rack. This piping shall also be kept separate from other copper piping to avoid incorrect usage.

## 12. Installer Performance Testing

- A. Testing shall be performed with oil-free, dry nitrogen. The installing Contractor shall perform the following steps:

1. **Blow Down**  
NFPA 99, 1999 4-3.4.1.2(a)
2. **Initial Pressure Test**  
NFPA 99, 1999 4-3.4.1.2(b)
3. **Cross-Connection Test**  
NFPA 99, 1999 4-3.4.1.2(c)
4. **Piping Purge Test**  
NFPA 99, 1999 4-3.4.1.2(d)
5. **Standing Pressure Test**  
NFPA 99, 1999 4-3.4.1.2(e)
  - a) Due to time schedules during construction, sections of piping systems can be tested so that walls can be closed-in. When sections of piping have been tested, the entire system must again be tested before final precertification and certification of the system.
  - b) Test apparatus shall be leak tested and found leak free before the start of the 24-hour test.

B. All items in this section shall be documented in a report by Contractor per NFPA 99.

### 13. System Verification and Certification

A. Testing shall be performed with oil-free, dry nitrogen. The installing Contractor shall perform the following steps: Cross connection testing and precertification of the medical gas system must be performed by a party technically competent and experienced in the field of medical gas pipeline testing. A party other than the installing Contractor shall perform the following testing:

1. **Cross-connection Test**  
NFPA 99, 1999 4-3.4.1.3(a)
2. **Valve Test**  
NFPA 99, 1999 4-3.4.1.3(b)
3. **Outlet Flow Test**  
NFPA 99, 1999 4-3.4.1.3(c)
4. **Alarm Testing**  
NFPA 99, 1999 4-3.4.1.3(d)
5. **Piping Purge Test**  
NFPA 99, 1999 4-3.4.1.3(e)



**6. Piping Purity Test**

NFPA 99, 1999 4-3.4.1.3(f)

- B. Medical gas system shall be tested in accordance with NFPA 99, latest edition and these specifications.
- C. Obtain and present to the Owner a complete bond report of pipeline precertification from the equipment manufacturer. This letter of precertification shall indicate:
  - 1. That the system is free of crossed connections.
  - 2. That all system components perform to the manufacturer's design specifications.
  - 3. That all system components, particularly the alarm system, have been installed in accordance with the manufacturer's recommendations.
- D. This report must be submitted to Engineering and Operations (E&O) a minimum of 48 hours before the desired date of the tie-in. E&O, Administration and Respiratory Therapy will coordinate the tie-in with the contractor.