

**SECTION 22 62 00**  
**VACUUM SYSTEMS FOR LABORATORY AND HEALTHCARE FACILITIES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Healthcare Vacuum Systems: Consisting of vacuum services; complete, ready for operation, including all necessary piping, fittings, valves, cabinets, station inlets, rough-ins, gages, alarms, including low voltage wiring and all necessary parts. Verify station inlet terminal connections with facility. BeaconMedaes is the equipment manufacturer requested by the facility.
- B. Vacuum system alarm wiring from piping to alarm panel.

**1.2 RELATED WORK**

- A. Sealing around pipe penetrations to maintain the integrity of fire rated construction: Section 07 84 00, FIRESTOPPING
- B. Sealing around pipe penetrations through the floor to prevent moisture migration: Section 07 92 00, JOINT SEALANTS.
- C. General requirements and items common to more than one section of Division 22: Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- D. Alarm interface with ECC: Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
- E. Laboratory and Healthcare Gases and Vacuum Alarms: Section 22 63 00, GAS SYSTEMS FOR LABORATORY AND HEALTHCARE FACILITIES.
- F. Laboratory and Healthcare Gas Piping and Equipment: SECTION 22 63 00, GAS SYSTEMS FOR LABORATORY AND HEALTHCARE FACILITIES.

**1.3 QUALITY ASSURANCE**

- A. Materials and Installation: In accordance with NFPA 99, and as specified.
- B. Equipment Installer: Show technical qualifications and previous experience in installing medical gas equipment on three similar projects. Submit names and addresses of referenced projects.
- C. Equipment Supplier: Show evidence of equivalent product installed at three installations similar to this project that has been in satisfactory and efficient operation for three years. Submit names and addresses where the product is installed.
- D. Medical Gas System Testing Organization: The testing shall be conducted by a party technically competent and experienced in the field of medical gas pipeline testing. Such testing shall be performed by a party other than the installing contractor.

- E. Provide names of three projects where testing of vacuum systems has been performed by the testing agency. Include the name of the project, names of such persons at that project who supervised the work for the project owner, or who accepted the report for the project owner, and a written statement that the projects listed required work of similar scope to that set forth in this specification.
- F. Submit the testing agency's detailed procedure which will be followed in the testing of this project. Include details of the testing sequence, procedures for cross connection tests, outlet function tests, alarm tests, purity tests, etc., as required by this specification. For purity test procedures, include data on test methods, types of equipment to be used, calibration sources and method references.
- G. Certification: Provide documentation prior to submitting request for final inspection to include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and a certification that all results of tests were within limits allowed by this specification.
- H. Installing contractor shall maintain as-built drawings of each completed phases for verification; and, shall provide the complete set at the time of final systems certification testing, for certification by the Third Party Testing Company. As-built drawings are to be provided, and a copy of them on Auto-Cad version (R-14 or later) provided on compact disk. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement.

#### **1.4 SUBMITTALS**

- A. Submit as one package in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data:
  - 1. Piping.
  - 2. Valves.
  - 3. Valve cabinets.
  - 4. Gages.
  - 5. Station inlets, and rough in assemblies.
  - 6. Alarm controls and panels.
  - 7. Vacuum switches.
  - 8. Vacuum bottle brackets.

- C. Station Inlets: Submit letter from manufacturer stating that inlets are designed and manufactured to comply with NFPA 99. Inlet shall bear label of approval as an assembly, of Underwriters Laboratories, Inc., or Associated Factory Mutual Research Corporation. In lieu of above labels, certificate may be submitted by a nationally recognized independent testing laboratory, satisfactory to the Contracting Officer, certifying that materials, appliances and assemblies conform to published standards, including methods of tests, of above organizations.
- D. Certification: The completed systems have been installed, tested, purged and analyzed in accordance with the requirements of this specification.

### 1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the test by the basic designation only.
- B. American National Standards Institute (ANSI):  
 A13.1-96.....Scheme for Identification of Piping Systems  
 B16.22-01.....Wrought Copper and Bronze Solder-Joint Pressure Fittings  
 B40.1-98..... Pressure Gauges and Gauge Attachments
- C. American Society for Testing and Materials (ASTM):  
 B819-00.....Standard Specification for Seamless Copper Tube for Medical Gas Systems
- D. American Society of Mechanical Engineers (ASME):  
 Section IX-04.....Welding and Brazing Qualifications
- E. American Welding Society (AWS):  
 AWS A5.8-92.....Brazing Filler Metal  
 AWS B2.2-91.....Standard for Brazing Procedure and Performance Qualification (Modified per NFPA 99)
- F. National Fire Protection Association (NFPA):  
 99-99.....Health Care Facilities
- G. Manufacturing Standardization Society (MSS):  
 MSS-SP-110-96.....Ball Valve Threaded, Socket Welding, Solder Joint, Grooved and Flared Ends  
 MSS-SP-73-03.....Brazing Joints for Copper and Copper Alloy Solder Pressure Fittings

## PART 2 - PRODUCTS

### 2.1 PIPING

- A. Copper Tubing: Type "K" or "L", ASTM B819, seamless copper tube, hard drawn temper, with wrought copper fittings conforming to ANSI B16.22 or brazing fittings complying with MSS SP-73. Size designated reflecting nominal inside diameter. All tubing and fittings shall be labeled "OXY", "OXY/MED", or "MED".
- B. Brazing Alloy: AWS A5.8, Classification BCuP, greater than 537 °C (1000 °F) melting temperature. Flux is strictly prohibited for copper-to-copper connections.
- C. Screw Joints: Polytetrafluoroethylene (teflon) tape.
- D. Memory metal couplings shall have temperature and pressure ratings not less than that of a brazed joint shall be permitted.
- E. Apply piping identification labels at time of installation in accordance with current NFPA. Supplementary color identification shall be in accordance with CGA Pamphlet C-9.
- F. Special Fittings: The following special fittings shall be permitted to be used in lieu of brazed joints:
  - 1. Memory-metal couplings having temperature and pressure ratings joints not less than that of a brazed joint.
  - 2. Listed or approved metallic gas tube fittings that, when made up, provide a permanent joint having the mechanical, thermal, and sealing integrity of a brazed joint.
  - 3. Axially swaged, elastic strain preload fittings providing metal to metal seal having pressure and temperature ratings not less than that of a brazed joint and when complete are permanent and non-separable.

### 2.2 VALVES

- A. Ball: In-line, other than zone valves in cabinets.
  - 1. Seventy five millimeter (2 1/2 inches) and smaller: Bronze/ brass body, Fed. Spec. MSS SP72 & SP 110 , Type II, Class 150, Style 1, with tubing extensions for brazed connections, full ported, three-piece or double union end connections, teflon seat seals, full flow, 4125 kPa (600 psi) WOG minimum working pressure, with locking type handle.
- B. Zone Valve in Cabinet: Ball valve, bronze/ brass body, double seal, three piece or double union end connections, replaceable teflon seat seals, teflon stem seal, 4125 kPa (600 psi) WOG, cold, non-shock gas

working pressure or vacuum service to 29 inch Hg, blowout proof stem, one quarter turn of handle to completely open or close. Provide tubing extensions factory brazed, pressure tested, cleaned for oxygen service. Provide 3 mm (1/8 inch) NPT gauge port for a 50mm (2 inch) diameter monitoring gauge upstream of the shut off valve. Zone valves shall be securely attached to the cabinet and provided with type-K copper tube extensions for making connection to system piping outside the cabinet. Zone valves shall be products of one manufacturer, and uniform throughout in pattern, overall size and appearance. Trim with color coded plastic inserts or color coded stick-on labels. Install valves in cabinets such that cover window cannot be in place when any valve is in the closed position. Color coding for identification plates and labels is as follows:

SERVICE LABEL	IDENTIFICATION COLORS	MFG. STD. CLR.
MEDICAL VACUUM	Black letters on white background	WHITE

### 2.3 VALVE CABINETS

- A. Refer to Section 22 63 00 GAS SYSTEMS FOR LABORATORY AND HEALTH CARE FACILITIES.

### 2.4 STATION INLETS: MG1, MG2, MG3

- A. For vacuum service, consisting of a quick coupler and inlet supply tube. Provide coupler that is non-interchangeable with other services, and leak proof under three times normal working pressure. Equip each station inlet with an automatic valve to conform with NFPA 99. Place valves in the assembly to provide easy access after installation for servicing and replacement, and to facilitate line blow-out, purging, and testing. Fasten each inlet securely to rough-in to prevent floating and provide each with a capped stub length of 1/2-inch outside tubing for connection to supply. Label stub tubing for vacuum service.

### 2.5 STATION INLET ROUGH-IN

- A. Flush mounted, protected against corrosion. Anchor rough-in securely to unit or wall construction.

- B. Modular Cover Plate: Die cast plate, two-piece .85 mm (22 gage) stainless steel or 1.6 mm (16 gage) chromium plated metal, secured to rough-in with stainless steel or chromium plated countersunk screws.
- C. Provide permanent, metal or plastic, identification plates securely fastened at each inlet opening, with inscription for appropriate service using color coded letters and background. Metal plates shall have letters embossed on baked-on enamel background. Color coding for identification plates is as follows:

SERVICE LABEL	IDENTIFICATION PLATE COLORS
MEDICAL VACUUM	Black letters on white background

## 2.6 VACUUM SWITCHES

- A. General purpose, contact or mercury type, allowing both high and low set points, with contact type provided with a protective dust cover; adjustable range set by inside or outside adjustment; switches activate when indicated by alarm requirements. Use one DISS demand check valve for each sensor switch.

## 2.7 VACUUM BOTTLE BRACKET

- A. Single, plate of one piece, .85 mm (22 gage) stainless steel or 1.6 mm (16 gage) chromium plated metal or aluminum, finish matching cover of adjoining vacuum inlet; keepers of same material as plate and anchored securely. Provide bracket and plastic vacuum bottle holder for each vacuum wall inlet.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. All accordance with current NFPA
- B. Keep open ends of tube capped or plugged at all times or otherwise sealed until final assembly.
- C. Cut piping square and accurately with a tube cutter (sawing not permitted) to measurements determined at place of installation. Ream tube to remove burrs, being careful not to expand tube, and so no chips of copper remain in the tube. Work into place without springing or forcing. Bottom tube in socket so there are no gaps between tube and fitting. Exercise care in handling equipment and tools used in cutting or reaming of tube to prevent oil or grease being introduced into tubing.

- D. Spacing of hangers: Current NFPA.
- E. While being brazed, joints shall be continuously purged with *oil free* nitrogen. The flow of purged gas shall be maintained until joint is cool to touch.
- F. Do not bend tubing. Use fittings.
- G. Apply pipe labeling during installation process and not after installation is completed. Size of legend letters shall be in accordance with ANSI A13.1.
- H. After initial leakage testing is completed, allow piping to remain pressurized with testing gas until testing agency performs final tests.
- I. Penetrations:
  - 1. Fire Stopping: Where pipes pass through fire partitions, fire walls or smoked partitions, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases as specified in Section 07 84 00, FIRESTOPPING, with intumescent materials only.
  - 2. Waterproofing: At floor penetrations, completely seal clearances around the pipe and make watertight with sealant as specified in Section 07 92 00, JOINT SEALANTS.
- J. Provide 40mm (1 1/2 inch) diameter line vacuum gage upstream of zone valve in cabinets.
- K. Provide zone valves in cabinets where indicated.

### 3.2 TESTS

- A. Installer Performed Tests:
  - 1. General.
    - a. The tests required by NFPA 99 5.1.12.2 shall be performed and documented by the installer prior to the tests required for System Verification.
    - b. The test gas shall be oil-free, dry Nitrogen NF.
    - c. Where manufactured assemblies are to be installed, the tests required by 5.1.12.2 shall be performed as follows:
      - 1. After completion of the distribution piping but before the standing pressure test.
      - 2. Prior to installation of manufactured assemblies supplied through flexible hose or flexible tubing.
      - 3. At all station outlets/inlets on installed manufactured assemblies supplied through copper tubing.

2. Initial Blow Down. Piping in medical gas and vacuum distribution systems shall be blown clear by means of oil-free, dry Nitrogen NF as follows:
  - a. After installation of the distribution piping.
  - b. Before installation of station outlets/inlets and other system components (e.g., pressure/vacuum alarm devices, pressure/vacuum indicators, pressure relief valves, manifolds, source equipment).
3. Initial Pressure Test.
  - a. Each section of the piping in medical gas and vacuum systems shall be pressure tested.
  - b. Initial pressure tests shall be conducted as follows:
    1. After installation of station outlets/inlets rough-in assemblies. Test caps shall be permitted to be used.
    2. Prior to the installation of components of the distribution piping system that would be damaged by the test pressure (e.g., pressure/vacuum alarm devices, pressure/vacuum indicators, line pressure relief valves, manufactured assemblies with flexible hose, hose, etc.)
  - c. The source shutoff valve shall remain closed during these tests.
  - d. The test pressure for pressure gases shall be 1.5 times the system working pressure but not less than a gauge pressure of 1035 kPa (150 psi).
  - e. The test pressure for vacuum shall be not less than a gauge pressure of 415 kPa (60 psi).
  - f. The test pressure shall be maintained until each joint has been examined for leakage by means of soapy water or other equally effective means of leak detection that is safe for use with oxygen.
  - g. Leaks, if any, shall be located, repaired (if permitted), replaced (if required), and retested.
4. Cross-Connection Test. It shall be determined that no cross-connections exist between the various medical gas and vacuum piping systems.
  - a. All piping systems shall be reduced to atmospheric pressure.
  - b. Sources of test gas shall be disconnected from all piping systems except for the one system being tested.
  - c. The system under test shall be charged with oil-free, dry Nitrogen NF to a gauge pressure of 345 kPa (50 psi).

- d. After the installation of the individual faceplates with appropriate adapters matching outlet/inlet labels, each individual outlet/inlet in each installed medical gas and vacuum piping system shall be checked to determine that the test gas is being dispensed only from the piping system being tested.
  - e. The cross-connection test shall be repeated for each installed medical gas and vacuum piping system.
  - f. The proper labeling and identification of system outlets/inlets shall be confirmed during these tests.
5. Piping Purge Test. The outlets in each medical gas piping system shall be purged to remove any particulate matter from the distribution piping.
- a. Using appropriate adapters, each outlet shall be purged with an intermittent high-volume flow of test gas until the purge produces no discoloration in a clean white cloth.
  - b. This purging shall be started at the closest outlet/inlet to the zone valve and continue to the furthest outlet/inlet within the zone.
6. Standing Vacuum Test for Vacuum System. After successful completion of the initial pressure tests, vacuum distribution piping shall be subjected to a standing vacuum test.
- a. Tests shall be conducted after installation of all components of the vacuum system.
  - b. The piping systems shall be subjected to a 24-Hour standing vacuum test.
  - c. Test pressure shall be between 300 mm (12 in.) HgV and full vacuum.
  - d. During the test, the source of test vacuum shall be disconnected from the piping system.
  - e. At the conclusion of the test, there shall be no change in the vacuum other than that attributed to changes of ambient temperature.
  - f. Test vacuum changes due to expansion or contraction shall be permitted to be determined by means of the following pressure-temperature relationship:
    - 1. The calculated final absolute pressure equals the initial absolute pressure times the final absolute temperature, divided by the initial absolute temperature.

2. Absolute pressure is the gauge pressure reading plus 101.4 kPa (14.7 psi).
3. Absolute temperature is the temperature reading plus 238°C (460°F).
4. The final allowable gauge pressure reading equals the final allowable absolute pressure minus a gauge pressure of 101.4 kPa (14.7 psi).

g. Leaks, if any, shall be located, repaired (if permitted) or replaced (if required), and retested.

B. Medical gas testing agency shall perform the following:

1. Perform and document all cross connection tests, labeling verification, supply system operation, and valve and alarm operation tests as required by, and in accordance with, current NFPA and the procedures set forth in pre-qualification documentation.
2. Verify that the systems, as installed, meet or exceed the requirements of current NFPA, this specification, and that the systems operate as required.
3. Inlet flow test:
  - a. Test all inlets for flow. Perform test with the use of an inert gas as described in CGA P-9.
  - b. Vacuum inlets must draw no less than 85 Lpm (3.0 scfm) with adjacent inlet flowing, at a dynamic inlet pressure of 40 kPa (12-inches Hg), and a static vacuum of 50 kPa (15-inches Hg).

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