

SECTION 22 62 00
VACUUM SYSTEMS FOR LABORATORY AND HEALTHCARE FACILITIES

SPEC WRITER NOTES:

1. Delete between // ---- // if not applicable to project. Also delete any other item or paragraph not applicable in the section and renumber the paragraphs.
2. References to pressure in this section are gage pressure unless otherwise noted.

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Central Laboratory and Healthcare Vacuum Systems: This section describes the labor, equipment, and services necessary for and incidental to the installation of piped medical vacuum systems and medical vacuum and waste anesthesia gas disposal systems (WAGD). Medical vacuum and WAGD systems shall be installed started, tested, and ready for use. The scope of work shall include all necessary piping, fittings, valves, cabinets, station outlets and inlets, rough ins, ceiling services, gages, alarms including low voltage wiring, vacuum pumps, electric motors and starters, receivers, and all necessary parts, accessories, connections and equipment for a complete and operational system. // Match existing station inlet terminal connections. //
- B. The contractor shall provide all elements and accessories required for a complete system according to the most recent edition of NFPA 99, Gas and Vacuum Systems.
- C. All necessary connections to owner furnished equipment shall be made as indicated on the contract documents. A separate construction isolation valve shall be made at the point of connection to an existing vacuum system.
- D. Electrical power and control wiring for vacuum pump(s), WAGD Producer(s), ceiling columns, alarms wiring from equipment to alarm panels, and modular accessories associated with the system(s) shall be included.
- E. Pressure testing, cross connection testing and final testing per NFPA 99 shall be performed.

SPEC WRITER NOTE: In most cases, the Medical Center will place the third party verify under a separate contract. If

Contractor will retain Verifier, use the following paragraph.

//F. The contractor shall retain a qualified third-party medical vacuum verifier acceptable to the engineer of record and VA to perform and attest to final verification of the systems. The contractor shall make all corrections as determined by this third-party verifier, including additional testing if necessary to attain full and unqualified certification at no additional time or cost to the Government.//

SPEC WRITER NOTE: OR if VA will retain Verifier, use the following paragraph.

//G. Coordinate with owner retained verifier for final verification of the systems. Make corrections as required, including additional testing if necessary to attain full certification. //

H. A complete listing of all acronyms and abbreviations are included in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

1.2 RELATED WORK

A. Section 01 00 00, GENERAL REQUIREMENTS.

B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.

//D. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.//

E. Section 07 84 00, FIRESTOPPING: Sealing around pipe penetrations to maintain the integrity of time rated construction.

F. Section 07 92 00, JOINT SEALANTS: Sealing around pipe penetrations through the floor to prevent moisture migration.

G. Section 10 25 13, PATIENT BED SERVICE WALLS: Prefabricated bedside patient units (PBPU).

//H. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Seismic Restraint.//

I. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING: General requirements and items common to more than one section of Division 22.

J. Section 22 05 12, GENERAL MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT: Electric motors.

//K. SECTION 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.//

L. Section 22 63 00, GAS SYSTEMS FOR LABORATORY AND HEALTHCARE FACILITIES: Laboratory and healthcare gases and vacuum alarms.

M. SECTION 22 63 00, GAS SYSTEMS FOR LABORATORY AND HEALTHCARE FACILITIES: Laboratory and healthcare gas piping and equipment.

SPEC WRITER NOTE: Delete the following paragraph if BAS is not included on project.

- N. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC: Alarm interface with BAS.
- O. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Control wiring.
- P. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduit.
- Q. Section 26 27 26, WIRING DEVICES: Electrical wiring and accessories.
- R. Section 26 29 11, MOTOR CONTROLLERS: Motor starters.

1.3 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.

SPEC WRITER NOTE: Make material requirements agree with applicable requirements specified in the referenced Applicable Publications. Update and specify, in both, that which applies to the project.

- B. American Society of Mechanical Engineers (ASME):
 - A13.1-2007 (R2013).....Scheme for the Identification of Piping Systems
 - B16.15-2013.....Cast Copper Alloy Threaded Fittings: Classes 125 and 250
 - B16.22-2013.....Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings
 - B16.50-2013.....Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings
 - B40.100-2013..... Pressure Gauges and Gauge Attachments
 - ASME Boiler and Pressure Code -
 - BPVC Section IX-2015....Welding, Brazing, and Fusing Qualifications
- C. American Society of Sanitary Engineers (ASSE):
 - 6000 Series-2012.....Professional Qualifications Standard for Medical Gas Systems Personnel
- D. American Society for Testing and Materials (ASTM):
 - B43-2014.....Standard Specification for Seamless Red Brass Pipe, Standard Sizes
 - B687-1999 (2011).....Standard Specification for Brass, Copper, and Chromium-Plated Pipe Nipples

- B819-2000 (R2011).....Standard Specification for Seamless Copper Tube
for Medical Gas Systems
- D1785-2012.....Standard Specification for Poly (Vinyl
Chloride) (PVC) Plastic Pipe, Schedules 40, 80,
and 120
- E. American Welding Society (AWS):
- A5.8M/A5.8-2011-AMD1....Specification for Filler Metals for Brazing and
Braze Welding
- B2.2/B2.2M-2010.....Specification for Brazing Procedure and
Performance Qualification
- F. Compressed Gas Association (CGA):
- P-9-2008.....The Inert Gases: Argon, Nitrogen, and Helium
- G. Manufacturing Standardization Society (MSS):
- SP-72-2010a.....Ball Valves with Flanged or Butt-Welding Ends
For General Service
- SP-110-2010.....Ball Valves Threaded, Socket-Welding, Solder
Joint, Grooved and Flared Ends
- H. National Electrical Manufacturers Association (NEMA):
- ICS 6-1993 (R2001, R2006) Industrial Control and Systems Enclosures
- I. National Fire Protection Association (NFPA):
- 70-2014.....National Electrical Code
- 99-2015.....Health Care Facilities Code

1.4 SUBMITTALS

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 22 62 00, VACUUM SYSTEMS FOR LABORATORY AND HEALTHCARE FACILITIES", with applicable paragraph identification.
- C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
1. Complete specifications for the product intended to be installed, dimensional drawings, and wiring schematics.
 2. Package drawing indicating package style, dimensions when complete, method of disassembly and sizes of subsections for rigging and installation.

3. Piping.
4. Valves.
5. Inlet and outlet cocks
6. Valve cabinets.
7. Gages.
8. Station inlets, and rough in assemblies.
9. Ceiling services.
10. Alarm controls and panels.
11. Vacuum switches.
12. Vacuum bottle brackets.
13. Vacuum pump systems (Provide certified pump test data at startup):
 - a. Pumps: Manufacturer and model.
 - b. Pump performance curves.
 - c. Pump operating speed (RPM).
 - d. Capacity: Free air exhaust from 65 and 80 kPa (19- and 24-inches Hg) gage vacuum (L/s) (SCFM).
 - e. Capacity: Expanded air capacity at 65 and 80 kPa (19- and 24-inches Hg) gage vacuum (L/s) (SCFM).
 - f. Type of bearing in pump.
 - g. Type of lubrication.
 - h. Type and adjustment of drive.
 - i. Electric motors: Manufacturer, frame and type.
 - j. Speed of motors (RPM).
 - k. Current characteristics and horsepower of motors.
 - l. Receiver capacity and rating.
 - m. Silencers: Manufacturer, type and model.
- D. Station Inlets: A letter from manufacturer shall be submitted 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.
- E. Certification: The completed systems have been installed, tested, purged and analyzed in accordance with the requirements of this specification. Certification shall be submitted to COR.
- F. A notarized affidavit from the verifier stating that the verifier undertakes to verify this project and thus agrees to disqualify themselves from supplying any equipment which shall be included in the scope of their verification. No verifier who supplies equipment shall be permitted to verify that equipment. Statement declaring that the

vacuum system manufacturer has no fiduciary interest in the verifier and that the verifier is not an agent or representative of the vacuum system manufacturer. Statement declaring that the contractor has no fiduciary interest in the third-party verifier and that the third-party verifier has no fiduciary interest in the contractor.

//G. Completed System Readiness Checklist provided by the CxA and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.//

//H. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.//

1.5 QUALITY ASSURANCE

- A. Contractor shall include with submittals an affidavit attesting to compliance with all relevant paragraphs of NFPA 99 most recent edition. Personnel assembling medical vacuum and WAGD system shall meet NFPA 99 5.1.10.11.10 "Qualification of Installers" and hold medical gas endorsements as under ASSE Standard Series 6000. The Contractor shall, on company letterhead, furnish documentation attesting that all installed piping materials were purchased cleaned and complied with the requirements of NFPA 99 5.1.10.1 and 5.1.10.2. Electrical Control systems and Medical vacuum Alarms are to be UL listed as assemblies with label affixed. Medical vacuum and WAGD controls are to be wired in accordance with NEC.
- B. Equipment Installer: The equipment installer shall provide documentation proving that the personnel installing the equipment meet the standards set by ASSE Standard Series 6000. Show technical qualifications and previous experience in installing medical gas equipment on three similar projects. Submit names, phone numbers, and addresses of referenced projects. The equipment installer shall perform the following coordination functions:
1. Coordinate with other trades to ensure timely installations and avoid conflicts and interferences.
 2. Coordinate and field verify with the metal stud partition installer and/or mason to ensure anchors, sleeves and similar items are provided in sufficient time to avoid delays; chases and openings are properly sized and prepared.

3. Coordinate with VA to ensure medical vacuum inlets, whether owner supplied or contractor supplied, in walls, ceiling and all equipment is provided by the same Medical Vacuum Equipment Manufacturer satisfactory to the owner.
 4. The contractor shall coordinate with the Medical Vacuum System Verifier to deliver a complete, operational, and tested medical gas installation ready for owner's use.
- C. Equipment Supplier: The Equipment supplier shall demonstrate evidence of installing equivalent product at three installations similar to this project that has been in satisfactory and efficient operation for three years. Names, phone numbers, and addresses where the product is installed shall be submitted for verification.
- D. Medical Gas System Testing Organization: The Medical vacuum verifier shall show documentation proving that the medical gas verifier meets the standards set by ASSE Standard Series 6000. 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 third-party testing company independent of the installing and general contractor.
- E. Names of three projects where testing of vacuum systems has been performed by the testing agency shall be provided. 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 shall be included in the documentation.
- SPEC WRITER NOTE: Design Engineer shall coordinate with COR amount of time required to allow shutdown.
- F. The testing agency's detailed procedure shall be followed in the testing of this project and submitted to COR 10 working days prior to testing. In the testing agency's procedure documentation, 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, data on test methods, types of equipment to be used, calibration sources and method references shall be submitted.

- G. Installation and Startup: The manufacturer shall provide factory authorized representatives to review the installation and perform the initial startup of the system. The factory authorized representatives shall submit a report to the COR and to the Contractor. The Contractor shall make all corrections identified by the factory authorized representative at no additional cost or time to the Government.
- H. Certification: The Final inspection documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and certification that all results of tests were within limits allowed by this specification.
- I. Bio-Based Materials: For products designated by the USDA's Bio-Preferred Program, provide products that meet or exceed USDA recommendations for bio-based content, so long as products meet all performance requirements in this specifications section. For more information regarding the product categories covered by the Bio-Preferred Program, visit <http://www.biopreferred.gov>.

1.6 MAINTENANCE SUPPORT

- A. The medical vacuum equipment manufacturer shall demonstrate a national factory direct service capability able to perform major overhauls. The medical vacuum equipment manufacturer shall provide factory direct preventative maintenance contract. The medical vacuum equipment manufacturer shall provide formal maintenance training courses. See paragraph "Demonstration and Training" for additional requirements for training. Servicer shall be no more than 100 miles away, be capable of responding within 4 hours, and provide certified personnel to perform all work.

1.7 AS-BUILT DOCUMENTATION

SPEC WRITER NOTE: Coordinate O&M Manual requirements with Section 01 00 00, GENERAL REQUIREMENTS. O&M manuals shall be submitted for content review as part of the close-out documents.

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit operation and maintenance data updated to include submittal review comments, substitutions and construction revisions shall be // in electronic version on compact disc or DVD // inserted into a three-ring binder. All aspects of system operation and maintenance

procedures, including piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices such as damper and door closure interlocks shall be included. A List of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner shall be required to employ shall be inserted into the As-Built documentation.

- C. The installing contractor shall maintain as-built drawings of each completed phase for verification; and shall provide the complete set at the time of final systems certification testing. As-built drawings are to be provided, and a copy of them in Auto-CAD version //____// provided on compact disk or DVD. 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.
- D. Certification documentation shall be provided to COR 10 working days prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and certification that all results of tests were within limits specified.

PART 2 - PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENTS

- A. A single Medical Vacuum Equipment Manufacturer shall supply the medical vacuum system(s) and equipment to include outlets, valves and gauges, valve boxes, alarm panels, manifolds, medical air, instrument air, vacuum and WAGD sources.

2.2 PIPING

- A. Copper Tubing: Copper tubing shall be type "K", ASTM B819, seamless copper tube, hard drawn temper, with wrought copper fittings conforming to ASME B16.22 or brazing fittings complying with ASME B16.50. The copper tubing size designated reflects nominal inside diameter. All tubing and fittings shall be labeled "ACR/OXY", "OXY", "OXY/MED", "ACR/MED", or "MED".

- B. **Brazing Alloy:** The brazing alloy shall comply with AWS A5.8M/A5.8, Classification BCuP, greater than 538 degrees C (1000 degrees F) melting temperature. Flux shall be strictly prohibited for copper-to-copper connections.
- C. **Screw Joints:** Screw joints shall use polytetrafluoroethylene (Teflon) tape.
- D. Use only copper or stainless-steel pipes for discharge from vacuum product (exhaust pipes).
- E. Memory metal couplings shall have temperature and pressure ratings not less than that of a brazed joint.
- F. Piping identification labels shall be applied at time of installation in accordance with NFPA 99. Supplementary color identification shall be in accordance with CGA Pamphlet C-9.
- G. **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. Dielectric fittings where required by the manufacturer of special medical equipment to electrically isolate the equipment from the piping distribution system.
 - 4. 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.

2.3 EXPOSED LABORATORY AND HEALTHCARE VACUUM PIPING

- A. **Finished Room:** Use iron pipe size (IPS) chrome plated brass or stainless-steel piping for exposed laboratory and healthcare vacuum piping connecting fixtures, casework, cabinets, equipment and reagent racks when not concealed by apron including those furnished by the Government or specified in other sections.
 - 1. **Pipe:** ASTM B43, standard weight.
 - 2. **Fittings:** Fittings shall comply with ASME B16.15 cast bronze threaded fittings with chrome finish (125 and 250 psig Classes).
 - 3. **Nipples:** Nipples shall comply with ASTM B687, chromium-plated.

4. Unions: Unions shall comply with MSS SP-72, MSS SP-110, brass or bronze with chrome finish. Unions 65 mm (2-1/2 inches) and greater shall be flange type with approved gaskets.
5. Valves: Valves shall comply with MSS SP-72, MSS SP-110, brass or bronze with chrome finish.

2.4 VALVES

- A. Ball: Ball valves shall be in line, other than zone valves in cabinets.
 1. 65 mm or DN65 (2-1/2 inches) and less: Ball valves shall be bronze/ brass body, MSS SP-72 and MSS 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, 4138 kPa (600 psig) WOG minimum working pressure, with locking type handle.
 2. 75 mm or DN75 to 100 mm or DN100 (3 to 4 inches): Ball valves shall be bronze/ brass body, MSS SP-72 and MSS SP-110, Type II, Class 150, Style 1 with tubing extensions brazed to flanges, full ported, three-piece, double seal, Teflon seals, full flow, 4138 kPa (600 psig) WOG minimum working pressure, with locking type handle.
- B. Check:
 1. 75 mm or DN75 (3 inches) and less: Check valves shall be brass and bronze body, straight through design for minimum pressure drop, spring loaded, self-aligning with Teflon cone seat, vibration free, silent operation, supplied NPT female threads at each end with flow direction arrow permanently cast into body, 2758 kPa (400 psig) WOG minimum working pressure.
 2. 100 mm or DN100 (4 inches) and greater: Check valves shall be iron body, bronze trim, swing type, vertical or horizontal installation, flange connection, 1035 kPa (150 psig) WSP with flow direction arrow permanently cast into body.
- C. Zone valve in cabinet shall be ball valve with bronze/ brass body, double seal, three piece or double union end connections, replaceable Teflon seat seals, Teflon stem seal, 4138 kPa (600 psig) WOG, cold, non-shock gas working pressure or vacuum service to 100 kPa (29.5 inches Hg), blowout proof stem, one quarter turn of handle to completely open or close. Tubing extensions, factory brazed, pressure tested, cleaned for oxygen service shall be provided. A 3.2 mm (1/8 inch) NPT gauge port shall be provided for a 50 mm (2 inch) diameter monitoring gauge downstream 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. Valves shall be 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
Evacuation (Waste Gas)	White letters on violet background	VIOLET

2.5 VALVE CABINETS

- A. Valve cabinets shall be flush mounted, commercially available item for use with medical gas services, constructed from steel not lighter than 1.3 mm (18 gage) steel or extruded aluminum not lighter than 1.9 mm (14 gage). The valve cabinets shall be rigidly assembled, of adequate size to accommodate all valve(s) and fittings indicated. Holes shall be predrilled to receive pipe connections. These pipe connections shall be made outside of the valve box. Anchors shall be provided to secure cabinet to wall construction. Openings in cabinet shall be sealed to be dust tight. Bottom of cabinet shall be located 1375 mm (4 foot 6 inches) above finished floor.
- B. Engraved rigid plastic identification plate shall be mounted on the wall above or adjacent to the cabinet. Color code identification plate to match gas identification colors as indicated above. Identification plate shall be clearly visible at all times. Inscriptions shall be provided on plate to read in substance: "VALVE CONTROL SUPPLY TO ROOMS." The final wording shall be approved by the COR or VA facility.
- C. Cover plate: The cover plate shall be fabricated from 1.3 mm (18 gage) sheet metal with satin chromed finish, extruded anodized aluminum, or 0.85 mm (22 gage) stainless steel. A cover window shall be provided of replaceable plastic, with a corrosion resistant device or lever secured to window for emergency window removal. The following shall be permanently painted or stenciled on window: "FOR EMERGENCY SHUT-OFF VALVES ONLY, SHUT-OFF VALVES FOR PIPED GASES", or equivalent wording. The valve cabinet shall be configured such that it is not possible to

install window with any valve in the closed position. Each valve shall have a pressure gauge upstream of valve and this pressure gauge shall be inside valve box.

- D. Cabinets and isolation valves shall be located and piped as shown on the contract documents, and at a minimum, so as to allow the isolation of each smoke compartment separately. Each cabinet shall serve no more than one smoke compartment.

2.6 GAGES

A. Vacuum Gages:

1. For vacuum line adjacent to source equipment the vacuum gages shall comply with ASME B40.100, vacuum gage type, size 115 mm (4-1/2 inches), gage listed for vacuum, accurate to within 2-1/2 percent, with metal case. The vacuum gage range shall be 0 to 100 kPa (0 to 29.5 inches Hg). Dial graduations and figures shall be black on a white background, or white on a black background. Label shall be for vacuum service. A gage cock shall be installed. Dual scale gages shall be installed for vacuum system.
2. For vacuum service upstream of main shut-off valve: A 40 mm (1-1/2 inches) diameter gage shall be provided with steel case, bourdon tube and brass movement, dial range 0 to 100 kPa (0 to 29.5 inches Hg). Dual scale gages shall be provided for vacuum system.

//2.7 STATION INLETS

A. Vacuum Station inlets:

1. Station inlets shall be for designated service, consisting of a quick coupler, quick disconnect type with inlet supply tube.
2. The outlet station shall be made, cleaned, and packaged to NFPA 99 standards and shall be UL listed and CSA certified.
3. A coupler shall be provided that is non-interchangeable with other services, and leak proof under three times normal working pressure.
4. Each station inlet shall be equipped with an automatic valve to conform with NFPA 99. Valves shall be placed in the assembly to provide easy access after installation for servicing and replacement, and to facilitate line blow-out, purging, and testing.
5. Each inlet shall be securely fastened to structure and provide each with a capped stub length of 7 mm (1/4 inches) (10 mm outside diameter) (3/8 inches outside diameter) tubing for connection to supply tubing. Stub tubing shall be labeled for appropriate service. Rough in shall be indexed and gas specified latch valve with non-

interchangeable safety keying with color coded gas service identification.

6. Rough-in kits and test plugs for PBPU shall be furnished under this specification but installed by manufacturer of PBPU before initial test specified herein.
7. Completion kits (valve body and face plate) shall be installed for the remainder of required tests.

B. For Ceiling Hose Drops:

1. Brass, stainless steel or chromed metal non-interchangeable DISS connections for appropriate service to conform with CGA V-5.
2. Hose assemblies shall be furnished for all ceiling stations for the finished ceiling height as indicated on the contract drawings. Each hose shall be provided with a heavy chain type dual retractor for vacuum. Retractors made of stainless steel are prohibited. An extra 450 mm (18 inches) of hose length shall be provided for retractors.
3. Each station inlet shall be equipped with an automatic valve to conform with NFPA 99. Valves shall be placed in the assembly to provide easy access after installation, for servicing and replacement, and to facilitate line blow-out, purging, and testing.
- //4. Each inlet shall be securely fastened to structure and provide each with a capped stub length of 7 mm (1/4 inches) (10 mm (3/8 inches) outside diameter) tubing for connection to supply tubing. Stub tubing shall be labeled for appropriate service for the installation. The installation shall be adjusted to compensate for variations in plaster or cover thickness. //

SPEC WRITER NOTE: Use the following paragraph if DISS connection inlets are to be furnished. To be used only to match existing during renovations.

//2.8 STATION INLETS

A. Vacuum Station Inlets:

1. Station inlets shall be brass, stainless steel, or chromed metal non-interchangeable DISS connections for appropriate service to conform with CGA V-5.
2. The outlet station shall be made, cleaned, and packaged to NFPA 99 standards and shall be UL listed and CSA certified.
3. A coupler shall be provided that is non-interchangeable with other services, and leak proof under three times normal working pressure. Threaded DISS connector shall be per CGA standards

4. Each station inlet shall be equipped with an automatic valve to conform with NFPA 99. Valves shall be placed in the assembly to provide easy access after installation for servicing and replacement, and to facilitate line blow-out, purging, and testing.
5. Each inlet shall be securely fastened to structure and provide each with a capped stub length of 7 mm (1/4 inch) 10 mm outside diameter (3/8 inch outside diameter) tubing for connection to supply tubing. Stub tubing shall be labeled for appropriate service. Rough in shall be indexed and gas specified latch valve with non-interchangeable safety keying with color coded gas service identification.
6. Rough-in kits and test plugs for PBPU shall be furnished under this specification but installed by manufacturer of PBPU before initial test specified herein.
7. Completion kits (valve body and face plate) shall be installed for the remainder of required tests.//

2.9 STATION INLET ROUGH-IN

- A. Station inlet rough in shall be flush mounted and protected against corrosion. Rough in shall be anchored securely to unit or wall construction.
- B. The modular cover plate shall be constructed from die cast plate, two-piece 0.85 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. The latch mechanism shall be designed for one handed, single thrust mounting and one-handed fingertip release of secondary equipment.
- C. Cover Plate for PBPU shall be one piece with construction and material as indicated for modular cover plate.
- D. Permanent, metal or plastic, identification plates shall be provided 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
EVACUATION (Waste Gas)	White letters on violet background

2.10 CEILING SERVICES

- A. Column accessories: Each utility column shall be equipped with flush type quick coupler vacuum service station inlets as specified under paragraph "Station Inlets". The following inlets, mounted on the utility column shall be provided: three medical vacuum and one anesthesia evacuation.
- B. Ceiling Mounted Station Inlets shall be equipped as specified under paragraph "Station Inlets". The station inlets shall be flush mount on ceiling and provide with hose tubing drops and retractors. Male thread DISS connection shall be extended through ceiling plate.
1. Hoses: Conductive, neoprene tubing hoses, color coded for appropriate service shall be capable of, dropping to within 1425 mm (4 feet 8 inches) from floor, with upper end of hose having female DISS connection with nut, easily finger tightened to ceiling inlet, and lower end of hose having DISS connection quick. Color coding for hoses is as follows:

SERVICE	HOSE COLOR
VACUUM	White
EVACUATION (Waste Gas)	Violet

2. Rough-in shall be standard metal single gang, interchangeable, sectional or one piece, securely anchored to ceiling runner channels. Ceiling plate shall be die cast plate, 0.85 mm (22 gage) stainless steel or 1.6 mm (16 gage) chromium plated metal. Identification plate shall be attached as specified in paragraph "Station Inlet Rough-In" to ceiling plate and attached adjacent to each inlet.
3. Hose retractor kit: The hose retractor kits shall be chrome plated; spring loaded assembly. Hose clamps shall have stainless steel sash chain; to automatically withdraw hose assembly a minimum of 508 mm (20 inches) from fully extended position of 1425 mm (4 feet 8 inches) to 1930 mm (6 feet 4 inches) above finished floor.

2.11 VACUUM SWITCHES

- A. Vacuum switches shall be general purpose, contact or mercury type, allowing both high and low set points, with contact type provided with a protective dust cover. The vacuum switch shall have an adjustable range set by inside or outside adjustment. Vacuum switches shall activate when indicated by alarm requirements. One orifice nipple (or DISS demand check valve) shall be used for each sensor switch.

SPEC WRITER NOTE: If no special cylinder gases are included on the project, delete the following paragraph.

2.12 VACUUM BOTTLE BRACKET

- A. Vacuum bottle bracket shall be single plate of one piece, 0.85 mm (22 gage) stainless steel or 1.6 mm (16 gage) chromium plated metal or aluminum, finish matching cover of adjoining vacuum inlet. All components shall be of same material as plate and assembly and anchored securely to structure. The bracket shall be provided and plastic vacuum bottle holder for each vacuum wall inlet.

2.13 LABORATORY VACUUM SYSTEMS

- A. // Duplex // Triplex // Multiplex // vacuum system. Factory assembled, piped and wired components shall include:"

SPEC WRITER NOTE: Use one of the following paragraphs for vacuum pump. The first technology presented is the older liquid ring type, still available and used in many medical centers.

- //1. The vacuum pumps shall be oil free, single stage, positive displacement, and non-pulsating liquid ring type. The vacuum pump shall be fitting with mechanical seals. Each vacuum pump shall be all iron construction with bronze or stainless-steel rotor and carbon steel shaft. The vacuum pump design shall not require more than annual maintenance intervals. Fresh seal water shall be minimal under operation and shall include a reservoir of sufficient capacity for 96 hours of operation without a fresh water supply. //

SPEC WRITER NOTE: The next technology choice is oil lubricated rotary vane vacuum pump.

- //2. The vacuum pumps shall be oil rotary vane type with dynamically balanced multi vane design with heavy duty aluminum alloy vanes for maximum heat dissipation. The minimum vane life shall be 50,000 operation hours. The oil recirculation design shall be differential pressure type with full recirculation and multistage exhaust oil separation rated at not less than 99.998 percent efficiency. Each vacuum pump shall be provided with an oil non return valve, filter change indicator for exhaust oil separation filters, and high discharge temperature switch. Service to the oil lubrication system filters shall not require disconnection of the exhaust piping. The oil lubrication system shall be enclosed in one module to minimize

oil leaks. Vacuum pumps that have exterior piping for oil lubrication are prohibited. Vacuum pumps requiring separate electrical motors for oil cooling are prohibited. Rubber hose flexible connections and hose clamps are prohibited.

3. Provide completely dry pumps equipped with self-lubricating carbon/graphite vanes. Bearings shall be lubricated and sealed. No oil is permitted in any pump. Each pump is completely air-cooled and has absolutely no water requirement. Each pump is fitted with a 5-micron inlet filter and is equipped with a vacuum relief valve, check valve to prevent backflow through off-cycle units, flexible connector, isolation valve, and vibration isolators at each mounting location. //

//B. The vacuum pumps shall be regenerative, dynamic type employing four stages of compression. The internal construction shall be absolutely friction-free and non-contacting with rotor turning freely in the housing. Each vacuum pump shall have four bearing points which require lubrication not more often than twice annually. Each vacuum pump shall be completely dry with no oil or other sealants anywhere inside the vacuum pump. Wearing vanes are prohibited. Vacuum pumps with non-contacting air ends driven by lubricated gear sets requiring oil seals between the oil chamber and compression chamber are prohibited. Each vacuum pump shall be equipped with a high exhaust temperature shutdown and alarm.

1. The vacuum pumps shall be non-contacting claw style rotary design. The internal construction shall be friction free and require no sealants. Each pump shall be air-cooled, and continuous duty rated. Each vacuum pump shall be provided with a single lubricated gearbox requiring an oil change not more often than 5,000 operating hours. Each vacuum pump shall be equipped with an exhaust silencer. Each pump shall be equipped with a high vacuum shutdown, a high temperature shutdown, and remote and local alarms. The lubricant supplied shall be inert with oxygen and the vacuum pump shall be factor cleaned for oxygen service.//

C. Each pump shall be directly connected to an induction motor, open-drip-proof, factory wound for 3 phase, 60 Hz, AC voltage as indicated on contract drawings. The motor shall be as specified in Section, 22 05 12, GENERAL MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT.

- //D. For liquid ring vacuum pumps, each pump shall be mounted on a base plate above an aluminum evaporative cooling reservoir to allow for heat dissipation. Equip reservoir with a water level valve and gauge glass. Other type heat exchangers are prohibited. This allows for water recirculation and a water reservoir for 48 hours without any purge city water.//
- E. A welded steel receiver tank shall be provided with gauge glass, relief valve and vacuum gauge. The receiver tank shall carry ASME Code, Stamp, and Certificate. The receiver tank shall be hot dip galvanized inside and out. The receiver tank shall not be used as a catch tank where a bio-hazard could develop. Any carryover of foreign materials such as liquids or tissue shall be intercepted at the inlet of the vacuum pump with filtration and discharged to sanitary sewer drain.
- F. The following accessories shall be factory piped in all brass piping and pre-wired to ensure proper operation of each vacuum unit:
1. Solenoid valves with manual bypass.
 2. Strainers.
 3. Anti-siphon fitting.
 4. 1 GPM flow control valves for liquid ring vacuum pumps.
 5. Inlet check valves suitable for vacuum service.
 6. Shut-off valves.
 7. Vacuum relief valve.
 8. Gage glass on reservoir tank and receiver tank.
- G. Control: For control of the unit, the following shall be included in a NEMA 12 pre-wired control panel factory mounted on the receiver. Panel shall be equipped with HOA switches and indicating lights along with the following:
1. Combination circuit breaker type magnetic across-the-line starters to provide overload and under voltage protection.
 2. 115-volt control transformers.
 3. Minimum run timers.
 4. Vacuum switches factory mounted and preset.
 5. Electric time alternator circuit to automatically switch the operation of each pump.
 6. Audible and visual alarm circuit with silence and reset button to activate when a pump starts out of sequence.
 7. Vibration isolators and flexible connections are supplied loose for field installation.

- H. The vacuum pumps shall be individually tested, and test results shall be submitted to the COR.

2.14 MEDICAL VACUUM SYSTEMS

SPEC WRITER NOTE: Provide a schedule on the drawings for the vacuum system.

- A. Provide a complete medical vacuum package, complying with NFPA 99 in all respects, as specified and scheduled in the contract documents. All components shall be factory packaged (pre-wired and pre-piped), on a steel base, or tank mounted. All package piping shall be type "K" rigid copper. Provide discharge separator/silencer.
- B. All components shall be //duplex// //triplex// //multiplex// and valved (or check valved as permitted NFPA 99) to allow service to any component without interrupting vacuum service to the facility during any maintenance operation or any condition of single fault failure. The design load shall be met with the largest single unit out of service. Each pump exhaust shall be isolated by a union fitting permitting capping for service removal.
- C. A complete and operational plant (source equipment) shall be furnished consisting of pumps, receiver and controls capable of providing the scheduled capacity with one pump out of service. All capacities shall be indicated in SCFM at 483 mm (19 inches Hg) and 600 mm (24 inches Hg).
- D. System shall be completely factory assembled, requiring only interconnection between modules on site. Systems requiring on site assembly other than interconnection are prohibited (replacement of components removed for shipping is permitted).
- E. Motor and Starter: Maximum 40 degrees C (104 degrees °F) ambient temperature rise, closecoupled to a NEMA rated, High Efficiency, TEFC motor with a service factor of 1.15, ball bearings, for operation with current, voltage, phase and cycle specified in Section 22 05 12, GENERAL MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT. Motor shall be of such capacity that brake horsepower required by driver equipment at normal rated capacity will not exceed nameplate rating of the motor. Provide each motor with automatic, fully enclosed, magnetic starter of type specified in Section 26 29 11, MOTOR CONTROLLERS.
- F. Each pump shall include inlet and outlet flex connectors supplied by the medical vacuum equipment manufacturer.

- G. Programmable Logic Controllers (PLC) or Direct Digital Controls (DDC) can be used to implement operating logic. Controls shall have integral memory and EPROM backup. Controls shall control the automatic alternation lead-lag of the vacuum pumps with provisions for simultaneous operation if required, and automatic activation of reserve or lag unit if required. A lag alarm on control cabinet and contacts for the master alarm shall be provided.
- H. The complete control system and all electrical components shall be NEMA ICS 6, Type 12 and UL labeled. The control system shall provide:
1. Automatic lead/lag sequencing including self-adjusting minimum run timers which adaptively optimize the number of pump starts based on demand.
 2. Circuit breaker disconnects for each vacuum pump with external operators. Units with fuses instead of circuit breakers in motor circuit are prohibited. The control system shall include an automatic minimum run time adjustment to automatically adjust run time based on demand.
 3. Full voltage motor starters with overload protection.
 4. Redundant 120-volt control circuit transformers.
 5. Visual and audible reserve unit alarm with isolated contacts for remote alarms and audio cancel.
 6. Control cabinet shall have lighted HOA selector switches
 7. Panel mounted vacuum gauge, external visual lights indicating on/off status, audible and visual signals for thermal overload, oil discharge filter differential pressure or back pressure alarm, and alarm silence button.
 8. Contacts for external oil discharge filter differential pressure or back pressure alarm
 9. If silence has been pressed, audible and visual signal would be reactivated upon second alarm condition. Alarm shall be reset upon correction of original signal.
 10. Runtime hour-meter for each pump.

SPEC WRITER NOTE: Specify one of the following 5 paragraphs, selecting between liquid ring, lubricated rotary vane, oil less rotary vane, dynamic, and claw type vacuum pumps.

- //I. The medical vacuum pumps shall be oil free, single stage, positive displacement, and non-pulsating liquid ring type. The vacuum pump shall

be fitted with mechanical seals. Each medical vacuum pump shall be all iron construction with bronze or stainless-steel rotor and carbon steel shaft. The medical vacuum pump design shall not require more than annual maintenance intervals. Fresh seal water shall be minimal under operation and shall include a reservoir of sufficient capacity for 96 hours of operation without a fresh water supply.//

//J. The medical vacuum pumps shall be oil rotary vane type with dynamically balanced multi vane design with heavy duty aluminum alloy vanes for maximum heat dissipation. The minimum vane life shall be 50,000 operation hours. The oil recirculation design shall be differential pressure type with full recirculation and multistage exhaust oil separation rated at not less than 99.998 percent efficiency. Each medical vacuum pump shall be provided with an oil non return valve, filter change indicator for exhaust oil separation filters, and high discharge temperature switch. Service to the oil lubrication system filters shall not require disconnection of the exhaust piping. The oil lubrication system shall be enclosed in one module to minimize oil leaks. Vacuum pumps that have exterior piping for oil lubrication are prohibited. Medical Vacuum pumps requiring separate electrical motors for oil cooling are prohibited. Rubber hose flexible connections and hose clamps are prohibited.//

//K. The medical vacuum pumps shall be completely dry pumps equipped with self-lubricating carbon/graphite vanes. The bearings shall be lubricated and sealed. No oil is permitted inside the medical vacuum pump. Each medical vacuum pump is completely air cooled and have zero water requirement. Each medical vacuum pump shall be fitted with a 5-micron inlet filter and equipped with a vacuum relief valve and check valve to prevent backflow through off-cycle periods. A flexible connector shall be provided at the connection to the inlet and discharge piping. Vibration isolation shall be furnished and installed.//

//L. The medical vacuum pumps shall be regenerative, dynamic type employing four stages of compression. The internal construction shall be absolutely friction-free and non-contacting with rotor turning freely in the housing. Each medical vacuum pump shall have four bearing points which require lubrication not more often than twice annually. Each medical vacuum pump shall be completely dry with no oil or other sealants anywhere inside the vacuum pump. Wearing vanes are prohibited.

Medical vacuum pumps with non-contacting air ends driven by lubricated gear sets requiring oil seals between the oil chamber and compression chamber are prohibited. Each medical vacuum pump shall be equipped with a high exhaust temperature shutdown and alarm.//

//M. The medical vacuum pumps shall be non-contacting claw style rotary design. The internal construction shall be friction free and require no sealants. Each medical vacuum pump shall be air-cooled, and continuous duty rated. Each medical vacuum pump shall be provided with a single lubricated gearbox requiring an oil change not more often than 5,000 operating hours. Each medical vacuum pump shall be equipped with an exhaust silencer. Each medical vacuum pump shall be equipped with a high vacuum shutdown, a high temperature shutdown, a remote alarm at the BAS and local alarms. The lubricant supplied shall be inert with oxygen and the medical vacuum pump shall be factory cleaned for oxygen service.//

N. The complete medical vacuum system and all electrical components shall be factory tested prior to shipment by the medical vacuum equipment manufacturer.

O. Waste Anesthetic Gas Disposal Pumps.

1. Provide a complete WAGD source, complying with NFPA 99 5.1.3.7 in all respects, as specified and scheduled.
2. All components shall be at least //duplex// //triplex// //multiplex// and valved to permit service to any component without interrupting WAGD supply to the facility during any maintenance operation or any condition of single fault failure.
3. Furnish complete and operational plant consisting of producer and controls capable of providing the scheduled capacity with one producer out of service.
4. System shall be completely factory assembled. Systems requiring site assembly are prohibited (removal of components for shipping is permitted).
5. Each producer shall include inlet and outlet flex connectors supplied by the medical vacuum equipment manufacturer.
6. A Programmable Logic Controller (PLC) or Direct Digital Controls (DDC) can be used to implement the operating sequence of operation. The controls shall have integral memory and EPROM memory backup. Alternating between the lead and lag WAGD pumps shall be made automatically by the programmable logic controller. The reserve unit

shall be automatically activated as required to maintain uninterrupted service. A provision for simultaneous operation of two or more WAGD pumps shall be made when one operating WAGD pump is not meeting the demand. An alarm shall be activated whenever a reserve WAGD producer or lag WAGD producer is activated.

7. The complete control system and all electrical components shall be NEMA 12 and UL labeled. The control system shall provide:
 - a. Automatic lead/lag sequencing.
 - b. Circuit breaker disconnects for each producer with external operators. Units with fuses instead of circuit breakers in motor circuit are prohibited.
 - c. Full voltage motor starters with overload protection.
 - d. Redundant 120-volt control circuit transformers.
 - e. Visual and audible reserve unit alarm with isolated contacts for remote alarms and audio cancel.
 - f. Control cabinet shall have lighted HOA selector switches
 - g. Runtime hour-meter for each producer.

SPEC WRITER NOTE: Specify one of the following 2 paragraphs, selecting between liquid ring, and claw type vacuum pumps.

//8. Liquid Ring: An oil-free, single-stage positive displacement, and non-pulsating liquid ring type pumps shall be provided. The pump shall be fitted with mechanical seals. Each pump shall be of all iron construction with a bronze or stainless rotor and carbon steel shaft. Maintenance intervals are calendar based and there is no hours-based maintenance. Under normal operation, system shall minimize fresh seal water required. System shall include reservoir sufficient for up to 48 hours operation without fresh water supply. System is self-contained. Provide vacuum regulation to maintain a maximum system vacuum of 175 mm (7 inches Hg).//

//9. Claw: A non-contacting claw style rotary pumps shall be provided. Internal construction is friction free and rotors are non-contacting. Air end is oil free and requires no sealants. Each pump is air cooled and continuous duty rated. Pump is provided with a single lubricated gearbox requiring lubricant change not more often than 5,000 operating hours. Pump is provided with exhaust silencer. Pumps shall be equipped with high vacuum shutdown, high temperature shutdown, and visual and audible alarms per NFPA 99. Lubricant

supplied shall be inert with oxygen. Pump shall be provided with vacuum modulated variable speed drive to control vacuum level at 175 mm (7 inches Hg).//

10. The complete WAGD system and all electrical components shall be factory pretested prior to shipment.

P. Controls:

1. Automatic: Adjustable, vacuum operated, automatic, electric switch to start and stop motor at receiver vacuum indicated. Provide heavy duty alternator, automatic, operating on a timed basis, to alternate the pumps by time forced alternation.
2. Control panel: Housed in a NEMA ICS 6, Type 12, listed, dust proof enclosure; prewired to include all specified electrical, electronic and electro pneumatic devices. Include wiring diagrams and operating descriptions in the cabinet. Include the following:
 - a. Circuit breakers for each control and motor circuit.
 - b. Hand off automatic selector switch for each pump.
 - c. Hour meter for each pump.
 - d. Control circuit transformers.
 - e. One magnetic motor starter for each pump.
 - f. Provide panel with external visual (lights, red for running, green for off) and audible (horn/buzzer) signals. The signals provided include:
 - 1) Pump in operation (visual only).
 - 2) Thermal overload shutdown (visual and audible).
 - 3) Oil discharge filter differential pressure or back pressure alarm (visual), with contacts for external signal. Wire to master alarm panel.
 - 4) Cancel button, which shall silence an audible alarm, reactivate should a second alarm occur while the horn is silenced, and reset automatically upon correction of the original signal.

- Q. Receiver Tank: The receiver tank shall be welded galvanized steel, in compliance with ASME Section VIII, 850 kPa (125 psig) working pressure stamped and certified. The receiver tank shall be equipped with vacuum gage and gage glass. The receiver tank shall be of sufficient capacity to ensure practical on/off operation of pumps.

- R. Bio-Hazard Safety Statement: "BIOHAZARD CAUTION: Fluid and waste material inside vacuum pipelines and vacuum equipment may be

contaminated with blood and other potentially infectious material. Construction and service personnel shall use proper PERSONAL PROTECTIVE EQUIPMENT and practice UNIVERSAL PRECAUTIONS when opening or servicing vacuum systems."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All installation shall be performed in strict accordance with NFPA 99 5.1.10. Brazing procedures shall be as detailed in NFPA 99 5.1.10.4. Brazing shall be performed only by Brazers qualified under NFPA 99 5.1.10.11.10. Where piping runs underground, the installation shall be made in accordance with NFPA 99 5.1.10.11.5.
- B. Contractor shall furnish 100 mm (4 inches) high concrete housekeeping pads. The contractor shall furnish inertia bases in lieu of housekeeping pads where the equipment installed is not factory isolated by the manufacturer. Anchor bolts shall be cast into bases
- C. Cast escutcheon shall be installed with set screw at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.
- D. Open ends of tube shall be capped or plugged at all times or otherwise sealed until final assembly to prevent infiltration of any foreign matter.
- E. Piping shall be cut square and accurately with a tube cutter (**sawing is prohibited**) to measurements determined at place of installation. The tubing shall be reamed to remove burrs, being careful not to expand tube, and so no chips of copper remain in the tube. The tubing shall be worked into place without springing or forcing. The tubing shall be bottomed in socket so there are no gaps between tube and fitting. Care shall be exercised in handling equipment and tools used in cutting or reaming of tube to prevent oil or grease from being introduced into the tubing. Where contamination has occurred, material shall be no longer suitable for vacuum service and new, sealed tube sections used.
- F. Piping shall be supported with pipe trays or hangers at intervals as shown on the contract drawings or as defined in NFPA 99. **Piping shall not be supported by other piping.** Isolation of copper piping from dissimilar metals shall be of a firm, positive nature. **Duct tape is prohibited as an isolation material.**
- G. Valves and other equipment shall be rigidly supported to prevent strain on tube or joints.

- H. Piping exposed to physical damage shall be protected.
- I. During any brazing operation, the interior of the pipe shall be purged continuously with oil free, dry nitrogen NF, following the procedure in NFPA 99 5.1.10.4.5. At the completion of any section, all open pipe ends shall be capped using an EXTERNAL cap. The flow of purged gas shall be maintained until joint is cool to touch. The use of flux is prohibited when making of joints between copper-to-copper pipes and fittings.
- J. Threaded joints in piping systems shall be avoided whenever possible. Where unavoidable, make up the male threads with polytetrafluoroethylene (such as Teflon) tape. Liquid sealants are prohibited.
- K. Tubing shall not be bent. Fittings shall be used in all change of direction or angle.
- L. After installation of the piping, but before installation of the outlet valves, blow lines clear using nitrogen NF per NFPA 99.
- M. Ceiling column assembly shall be supported from heavy sub-mounting castings and furnished with the unit as part of rough in. Ceiling columns shall be anchored with 15 mm (1/2 inch) diameter bolts attached to angle iron frame supported from structural ceiling.
- N. Two 25 mm (1 inch) minimum conduits shall be provided from ceiling column assembly to the adjacent corridor, one for mass spectrometer tubing and wiring and one for monitor wiring, and for connection to signal cabling network.
- O. Pressure and vacuum switches, transmitter and gauges shall be installed to be easily accessed and provide access panel where installed above plaster ceiling. Pressure switch and sensors shall be installed with orifice nipple between the pipeline and switches/sensors.
- P. Pipe labeling shall be applied during installation process and not after installation is completed. Size of legend letters shall be in accordance with ASME A13.1.
- Q. After initial leakage testing is completed, the piping shall be allowed to remain pressurized with testing gas until testing agency performs final tests.
- R. Penetrations:
 - 1. Fire Stopping: Where pipes pass through fire partitions, fire walls, smoked partitions, or floors, fire stopping shall be installed that provides an effective barrier against the spread of fire, smoke and

- gases as specified in Section 07 84 00, FIRESTOPPING, Clearances between raceways and openings with the fire stopping material shall be completely filled and sealed.
2. Water proofing: At floor penetrations, clearances shall be completely sealed around the pipe and made watertight with sealant as specified in Section 07 92 00, JOINT SEALANTS.
- S. A vacuum gage 40 mm (1-1/2 inch) diameter shall be installed in line downstream of each valve located in a zone valve cabinet.
- T. Zone valves shall be provided in cabinets where indicated and outside each Operating Room and a minimum one zone valve assembly for each 18 outlets.
- U. Piping shall be labeled with name of service, identification color and direction of flow. Where non-standard pressures are piped, pressure shall be labeled. Labels shall be placed at least once every 6.1 m (20 feet) of linear run or once in each story (whichever is more frequent). A label shall additionally be placed immediately on each side of all wall or floor penetrations. Pipe labels shall be self-adhesive vinyl type or other water-resistant material with permanent adhesive colored in accordance with NFPA 99 Table 5.1.11 and shall be visible on all sides of the pipe. Each master alarm signal shall be labeled for function after ring out. Each zone valve shall be labeled and each area alarm labeled for the area of control or surveillance after test. Labels shall be permanent and of a type approved by the VAMC.
- V. Alarms and valves shall be labeled for service and areas monitored or controlled. Coordinate with the VAMC for final room or area designations. Valves shall be labeled with name and identification color of the gas and direction of flow.

3.2 INSTALLER TESTING

- A. Prior to declaring the lines ready for final verification, the installing contractor shall strictly follow the procedures for verification as described in NFPA 99 5.1.12.2 and attest in writing over the notarized signature of an officer of the installing company the following:
1. That all brazing was conducted by Brazer qualified to ASSE Standard Series 6000 and holding current medical gas endorsements.
 2. That all brazing was conducted with nitrogen purging. (Procedure per NFPA 99 5.1.10.4.5).

3. That the lines have been blown clear of any construction debris using oil free dry nitrogen or air are clean and ready for use. (Procedure per NFPA 99 5.1.12.2.2).
 4. That the assembled piping, prior to the installation of any devices, maintained a test pressure 1 1/2 times the standard pressures listed in NFPA 99 Table 5.1.11 without leaks. (Procedure per NFPA 99 5.1.12.2.3).
 5. That after installation of all devices, the pipeline was proven leak free for 24 hours at a pressure 20 percent above the standard pressures listed in NFPA 99 Table 5.1.11. (Procedure per NFPA 99 5.1.12.2. 6)
 6. That the systems have been checked for cross connections and none were found. (Procedure per NFPA 99 5.1.12.2.4)
 7. That the manufacturer has started up all medical air compressors, medical vacuum pumps WAGD producers, liquid oxygen system(s) and manifolds, and that they are in operating order.
- B. Four originals of the affidavit shall be distributed: (2) to the COR, (1) to the general contractor, and (1) to the verifier (www.mgpho.org).

SPEC WRITER NOTE: Where the system change is minor delete the following.

3.3 VERIFIER TESTING

- A. Prior to handing over the systems to VAMC, the contractor shall retain a verifier acceptable to the engineer of record and VA who shall follow strictly the procedures for verification as described in NFPA 99 5.1.12.3 and provide a written report and certificate bearing the notarized signature of an officer of the verification company on company letterhead which contains at least the following:
1. A current ACORD insurance certificate indicating professional liability coverage in the minimum amount of \$1 Million per occurrence, and general aggregate liability in the minimum amount of \$1 Million, valid and in force when the project is to be verified. General liability insurance alone is not acceptable.
 2. An affidavit bearing the notarized signature of an officer of the verification company stating that the verification company is not the supplier of any equipment used on this project or tested in this report and that the verification contractor has no relationship to, or pecuniary interest in, the manufacturer, seller, or installer of any equipment used on this project or tested in this report.

3. A listing of all tests performed, listing each source, outlet, valve and alarm included in the testing.
4. An assertion that all tests were performed by a Medical Vacuum System Certified Medical Gas or vacuum Verifier or by individuals qualified to perform the work and holding valid qualifications to ASSE 6030 and under the immediate supervision a Verifier. Include the names, credential numbers and expiration dates for all individuals working on the project.
5. A statement that equipment used was calibrated at least within the last six months by a method traceable to a National Bureau of Standard Reference and enclosing certificates or other evidence of such calibration(s). Where outside laboratories are used in lieu of onsite equipment, those laboratories shall be named, and their original reports enclosed.
6. A statement that where and when needed, equipment was re calibrated during the verification process and describing the method(s) used.
7. A statement that the systems were tested and found to be free of debris to a procedure per NFPA 99 5.1.12.3.7.
8. The flow from each outlet when tested to a procedure per NFPA 99 5.1.12.3.10.
9. A statement that the systems were tested and found to have no cross-connections to a procedure per NFPA 99 5.1.12.3.3.
10. A statement that the systems were tested and found to be free of contaminants to a procedure per NFPA 99 5.1.12.3.8 except that the purity standard shall be 2 ppm difference for halogenated hydrocarbons and 1 ppm total hydrocarbons (as methane).
11. Statement that all local signals function as required under NFPA 99 5.1.3.5.8 and as per the relevant NFPA 99 sections relating to the sources.
12. A listing of local alarms, their function and activation per NFPA 99 5.1.12.3.14.
13. A listing of master alarms, their function and activation, including pressures for high and low alarms per NFPA 99 5.1.12.3.5.2.
14. A listing of area alarms, their function and activation pressures per NFPA 99 5.1.12.3.5.3.
15. A statement that the sources include all alarms required by NFPA 99 Table A.5.1.9.5.

16. The concentration of each component of NFPA 99 Table 5.1.12.3.11 in the medical air after 24 hours of operation of the medical air source.
 17. The concentration of each gas at each outlet as specified in NFPA 99 5.1.12.3.11.
 18. A statement that all valves and alarms are accurately labeled as to zone of control.
- B. 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 NFPA 99 and the procedures set forth in pre-qualification documentation.
- C. Verify that the systems, as installed, meet or exceed the requirements of NFPA 99, this specification, and that the systems operate as required.
- D. Piping purge test: For each positive pressure gas system, verify cleanliness of piping system. Filter a minimum of 1000 liters (35 cubic feet) of gas through a clean white 0.45-micron filter at a minimum velocity of 100 mps (3.5 fpm). Filter shall show no discoloration and shall accrue no more than 0.1 mg of matter. Test each zone at the outlet most remote from the source. Perform test with the use of an inert gas as described in CGA P-9. Retest until all tests pass at no additional time or cost to the Government.
- E. Inlet flow test:
1. Test all inlets for flow. Perform test with the use of an inert gas as described in CGA P-9.
 2. Needle valve vacuum inlets shall draw no less than 1.0 SCFM with adjacent inlet flowing, at a dynamic inlet pressure of 40 kPa (12 inches Hg), and a static vacuum of 10 kPa (3 inches Hg).
 3. Vacuum inlets shall 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).
 4. Anesthesia evacuation inlets shall draw no less than 1 L/mm (1.0 SCFM) at a dynamic inlet pressure of 40 kPa (12 inches Hg), and a static vacuum of 50 kPa (15 inches Hg).

3.4 CONNECTION TO EXISTING LABORATORY VACUUM SYSTEM

- A. Contactor shall test the existing system for hydrocarbons, dew point, etc. per NFPA 99. If problems are present, the COR would notify the

facility of the results. The facility would then make the necessary repairs and/or maintenance.

- B. Double shut-off valves shall be installed at the connection of new line to existing line.
- C. Time for shutdown of the existing vacuum system shall be coordinated at least 10 workdays prior to shutdown with the COR and VA Medical Center.
- D. Prior to any work being done, new pipeline shall be checked for particulate or other forms of contamination per NFPA 99.
- E. Ensure that the correct type of pipe tubing and fittings are being used.
- F. A spot check of the existing pipelines shall be made in the facility to determine the level of cleanness present.
- G. The tie-in shall be made as quickly as possible. A nitrogen purge is not required since this would require another opening in the pipe.
- H. After the tie-in is made and allowed to cool, slowly bleed the source vacuum back into the pipeline. Test the work area for leaks with soapy water and repair any leaks.
- I. After all leaks, if any, are repaired and the line is fully recharged, perform blow down and testing. Open the zone that is closest to the main to the system, access the closest outlet to the work, and blow the main through the inlet. After the inlet blows clear into a white cloth, make an additional check at a zone most distant from the work. Perform all required NFPA 99 tests after connection.

//3.5 COMMISSIONING

- A. Provide commissioning documentation in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.//

3.6 DEMONSTRATION AND TRAINING

- A. Provide services of manufacturer's technical representative for //four// // // hours to instruct VA Personnel in operation and maintenance of the system.
- //B. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.//

- - - E N D - - -