3) Apply the alloy at the bottom of the fitting cup, working the alloy up each side. Braze in an upward motion to the top of the fitting cup.
4) Proceed around the tube, being sure to overlap the braze from segment to segment.

b) The brazing alloy shall be visible completely around the outside edges of the joint. After the braze is complete, allow both the fitting and tube to become cool to the touch.
c) Nitrogen NF purge shall remain flowing during the cooling process.
d) Cap all open tube ends immediately upon completion of brazing, leaving the pipeline filled with nitrogen NF.

A.10 Visual Examination of Brazed Joints

A.10.1 Purpose

The purpose of this section is to determine the visual condition of medical gas and vacuum joints.

A.10.2 Requirement

Each joint in the pipeline shall be visually inspected.

A.10.3 Procedure

a) Wash each joint with water – with hot water where flux is used.
b) Visually check that braze filler metal has flowed into, and is evenly distributed, around the edges of the fitting cup.
c) The following conditions are unacceptable:
1) Flux or flux residue present (from the use of BAg series rod used only on dissimilar metals).
2) Excessive oxidation of the joint, as indicated by base metal melting or erosion.
3) Presence of un-melted filler metal.
4) Failure of the filler metal to be clearly visible all the way around the joint at the interface between the socket and the tube.
5) Cracks in the tube or component.
6) Cracks in the filler metal.
d) Joints that fail due to conditions 2 or 5 under A.10.3.c shall be replaced. Joints that fail due to conditions 1, 3, 4 or 6 shall be permitted to be reheated one (1) time before being replaced.

A.11 Welding of Medical Gas and Vacuum Piping Systems

A.11.1 Purpose

The purpose of this section is to establish qualification requirements for welding joints in medical gas and vacuum piping systems using the GTAW autogenous orbital procedure.

A.11.2 Requirement

Only installers who have been qualified under the requirements of NFPA 99, using welding procedures that have been qualified under NFPA 99, shall be permitted to weld joints in medical gas and vacuum piping systems.

A.11.3 Procedure

Copper-to-copper joints shall be purged with a mixture of 75% helium and 25% argon (± 5%) when using the GTAW autogenous orbital procedure.

A.11.4 Inspections

a) The outside (O.D.) of each production weld shall be inspected by the installer. Any obvious defective joints shall be cut out and replaced.
b) Test coupons shall be welded and inspected as follows:
1) At the start of work;
2) Every 4 hours thereafter;
3) If the machine is idle for more than 30 minutes;
4) If the operator is changed;
5) If the weld head is changed;
6) If the welding electrical power source is changed;
7) If the purge gas source is changed; and
8) At the end of the work period.
c) The inside (I.D.) and outside (O.D.) of all test coupons shall be inspected in accordance with current industry standards and practices.

A.12 Special Fittings

A.12.1 Purpose

The purpose of this section is to list special fittings that are permitted to be used in medical gas and vacuum piping systems. Approved special fittings include:

a) Memory-metal couplings having temperature and pressure rating joints not less than that of a brazed joint.
b) Listed and approved metallic gas tube fittings that, when made up, provide a permanent joint having the mechanical, thermal and sealing integrity of a brazed joint.

c) Dielectric fittings where required by the manufacturer of special medical equipment to electrically isolate the equipment from the piping distribution system.
d) Axially swaged, elastic strain preload fittings providing metal to metal seals having pressure and temperature ratings not less than that of a brazed joint and when complete are permanent and non-separable and shall be permitted to be used to join copper or stainless steel tube.

A.12.2 Requirement

Special fittings shall be applied in accordance with the manufacturer's recommendations.

A.12.3 Procedure

Special fittings shall be installed in accordance with the manufacturer's instructions.

A.13 Tests by the Installer

A.13.1 Purpose

The purpose of this section is to have the installer perform and document (see Annex M) certain inspections and tests on the installed piping to determine if it is ready for verification under ASSE Standard 6030.

A.13.2 Requirement

The following tests shall be performed prior to verification under ASSE 6030.

a) Initial blow down
b) Initial pressure test
c) Initial cross-connection test
d) Piping purge test
e) Standing pressure tests (for positive pressures and vacuum)

A.13.3 Manufactured Assemblies

Where manufactured assemblies with flexible hoses are tested by the manufacturer, the initial blow-down test and the initial pressure test do not need to be repeated by the installer.

A.14 Initial Blow-down

A.14.1 Purpose

The purpose of this section is to blow debris out of the mains, branches and drops of the medical gas and vacuum distribution piping.

A.14.2 Requirement

After installation of the piping, but before installation of the station outlets, vacuum inlets and other medical gas systems components (e.g., pressure switches or transducers for alarms, pressure gauges or pressure relief valves), the line shall be blown clear using nitrogen NF.

A.14.3 Medical Gas and Vacuum Distribution System

Blow-down Procedure

a) Connect the nitrogen NF to the pipeline using suitable regulators.
b) Rapidly turn on and off the flow of nitrogen NF to the maximum flow available, but no less than 225 LPM (8 SCFM), until no debris is noted to be discharged from the end of the portion of the pipeline being blown down.
c) Replace the cap or plug on the end of the tube, leaving it filled with nitrogen NF.

A.15 Initial Pressure Tests

A.15.1 Purpose

The purpose of this test is to verify the pressure integrity of the medical gas and vacuum piping system.

A.15.2 Requirement

a) This test shall be performed:
   1) Before the attachment of system components (e.g. pressure switches or transducers for alarms, pressure gauges or pressure relief valves), but after installations of the station outlets and inlets;
   2) Before closing of the walls or concealing any piping; and
   3) After inspectors are notified as to when the test will be performed so it can be witnessed and the results can be recorded.
b) Each section of the piping system for medical gases and medical support gases shall be subjected to a test pressure of 1.5 times the working pressure and a minimum 1035 kPa (150 psig) with nitrogen NF.
c) Each section of the medical-surgical vacuum and WAGD piping systems shall be subjected to a test pressure of 1035 kPa (150 psig) minimum with nitrogen NF.

A.15.3 Procedure

a) Pressurize and maintain the pipeline at the test pressure required in Section A.15.2.b or Section A.15.2.c.

b) Examine each joint for leakage by means of a leak detectant, free of ammonia and chlorides, or other equally effective means of leak detection that is safe for use with oxygen.
c) Leaks, if any, shall be located, repaired if permitted by Section A.10.3.d, or replaced and retested.

A.16 Cross-Connection Test (Initial)

A.16.1 Purpose

This initial test determines if cross-connections (i.e. one gas pipeline is inadvertently connected to another gas pipeline) exist within the medical gas and vacuum distribution systems. The final cross-connection test is part of system verification under ASSE Standard 6030.

A.16.2 Requirement

a) It shall be determined that no cross-connections exist between the station outlets or vacuum inlets of the various medical gas and vacuum distribution systems. Each outlet and inlet shall be connected to the proper distribution piping system.
b) The cross-connection tests shall be conducted while the piping is readily accessible for the correction of cross-connections, if necessary. In the case of headwall units and other wall-mounted equipment (including station outlets and inlets), walls may be closed prior to the cross-connection tests, provided that all individual branch piping remain readily accessible beyond the closed wall.

A.16.3 Procedure

a) All medical gas and vacuum systems shall be reduced to atmospheric pressure.
b) All sources of test gas shall be disconnected from all of the medical gas and vacuum systems with the exception of the one system to be checked. This system shall be pressurized with nitrogen NF to 345 kPa (50 psig) gauge pressure.
c) With appropriate adapters matching outlet/inlet labels, check every station outlet/inlet in each medical gas and vacuum system to determine that the test gas is being dispensed only from the outlets/inlets of the system being tested.
d) The source of test gas shall then be disconnected and the tested system shall be reduced to atmospheric pressure.
e) Proceed to the next system and repeat the previous process, again testing every station outlet and inlet in every system for each system test.
f) Each station outlet and inlet shall be identified by label.
g) The presence and correctness of labeling for all components (e.g. station outlets/inlets, shut-off valves, alarm panels) shall be checked.

A.17 Initial Piping Purge Test

A.17.1 Purpose

This procedure purges particulate matter from the station outlets in positive-pressure medical gas systems.

A.17.2 Requirement

A heavy, intermittent purging, greater than 225 LPM (8 SCFM), shall be applied at each outlet.

A.17.3 Purge Procedure

a) The purge gas shall be nitrogen NF.
b) Obtain the appropriate, gas-specific adapter for each system to be purged.
c) Pressurize the piping system to normal operating pressure.
d) Flow each outlet with a pulse purge (intermittent) until the purge produces no discoloration in a white cloth held in front of the gas stream.
e) If the particulates continue, the outlet may require disassembly (removal of the valve assemblies) and purging, similar to Section A.14.

A.18 Standing Pressure/Vacuum Tests

A.18.1 Purpose

The purpose of this section is to determine the pressure integrity of the medical gas and vacuum distribution system after the walls have been closed and the final components have been installed.

A.18.2 Requirement

After testing each individual medical gas and vacuum system for cross-connections in accordance with Section A.16, the station outlets and all other medical gas systems components (e.g. pressure/vacuum switches or transducers for alarms, pressure/vacuum gauges or pressure relief valves) shall be installed. All positive pressure gas systems shall be subjected to a 24-hour standing pressure test at 20% above the normal operating line pressure. Vacuum piping systems shall be subjected to a 24-hour standing vacuum test. These tests shall be witnessed by the Authority Having Jurisdiction (AHJ) or its designee.

A.18.3 Test Procedure for Positive Pressure Gas Piping Systems

The test gas shall be nitrogen NF. The source shut-off valve shall be closed.

In Canada: Leak testing gas shall be oil-free dry air or nitrogen NF.

a. After the piping system is filled with test gas, all outlets and the appropriate supply valve shall be closed and the source of test gas disconnected.
b. The piping system shall remain leak-free for 24 hours. The 24-hour standing pressure test shall be witnessed by the Authority Having Jurisdiction (AHJ) or its designee.
c. Leaks, if any, shall be located, repaired if permitted by Section A.10.3.d, or replaced and retested.

A. 18.4 Test Procedures for Vacuum Systems

The vacuum source equipment may be used for this test if it has been inspected and is ready for operation. Otherwise, a test vacuum pump must be used.

a. The pressure in the vacuum piping system shall be reduced to a vacuum of not less than 300 mm (12 inches) gauge Hg vacuum.
b. The source of test vacuum shall be disconnected from the system during the test period. The 24-hour standing vacuum test shall be witnessed by the Authority Having Jurisdiction (AHJ) or its designee.
c. At the end of the 24-hour test period, there shall be no change in the vacuum level.
d. Leaks, if any, shall be located, repaired or removed, and tested. Brazed joints in vacuum piping shall be permitted to be repaired, except that no joint shall be reheated more than one (1) time before being replaced.

A.19 Category 1 Piped Medical Gas and Vacuum Systems

A.19.1 Where required, refer to NFPA 99, Chapter 4, Section 4.1.1.

A.20 Category 2 Piped Medical Gas and Vacuum Systems

A.20.1 Where required, refer to NFPA 99, Chapter 4, Section 4.1.2.

A.21 Category 3 Piped Medical Gas and Vacuum Systems

A.21.1 Where required, refer to NFPA 99, Chapter 4, Section 4.1.3.

Performance Requirements for Medical Gas Systems Inspectors Qualified Under ASSE Standard 6020

This annex is provided for informational purposes only and is not a mandatory part of ASSE Standard 6020. It reflects the inspection requirements for medical gas systems in different parts of the country.

B.1 Administration

B.1.1 Inspector's Log

A log that contains records of site observations and test results may be required for inspectors.

B.1.2 Test and Inspection Reports

The inspector shall personally witness the various tests and record the results of the tests performed by the installer as required.

B.2 Documents and Recording of Inspections and Tests

B.2.1 The Inspector shall verify that the following documents are on file at the jobsite:

a) Building permit
b) Shop drawings
c) Manufacturer's literature and data
d) Manufactured assembly test documentation for each manufacturer's unit
e) Copper tubing cleaned for oxygen service documentation
f) Copper fittings cleaned for oxygen service documentation
g) Brazing alloy documentation
h) Purge and test gas documentation
i) Qualification of brazing procedure specification (Section A.9.2)
j) Brazer performance qualification record (Section A.9.2)
k) Qualification of welding procedures and welders, if used
l) Medical Gas System Installer certifications to ASSE Standard 6010 for each Medical Gas Systems Installer
m) Medical Gas Systems Verifier certifications to ASSE Standard 6030
n) Bulk Medical Gas Systems Installers certifications to ASSE Standard 6015

B.2.2 The Medical Gas Systems Inspector shall confirm the following:

a) Use of proper piping materials and joining methods
b) Proper handling and installation of materials, including supports
c) Brazed piping purged with nitrogen NF while being brazed and capped or plugged during the installation process
d) Welded piping purged with shield gas while being welded and capped or plugged during the installation process
e) Labeling and identification (see Section C.17)
f) Installation of manifolds (see Annex H)
g) Installation of bulk medical gas supply sources (see Annex I)
h) Installation of medical compressed air source equipment (see Annex F)
i) Installation of medical vacuum source equipment (see Annex G)
j) Installation of alarm panels

B.2.3 The Medical Gas Systems Inspector shall verify the test reports for the following:

a) Visual inspection of brazed and welded joints
b) Inspection of all welded test coupons
c) Initial piping blow-down
d) Initial pressure test
e) Initial cross-connection test
f) Standing pressure test
g) Standing vacuum test
h) Initial piping purge test

B.2.4 The Medical Gas Systems Inspector shall obtain a copy of the final system verification report performed in accordance with Annex C.

B.2.5 The Medical Gas Systems Inspector report data shall include:

a) Medical Gas Systems Inspector identification
b) Medical Gas Systems Inspector signature
c) Date of test

Field Verification / Testing Procedures for Medical Gas Systems by Verifiers Qualified Under ASSE Standard 6030

This annex is provided for informational purposes only and is not a mandatory part of ASSE Standard 6030. It reflects the verification requirements of NFPA 99-2015.

C.1 Preparation

C.1.1 Notification

As necessary, obtain permission from the owner or agent, and the on-site representative to shut down the medical gas and vacuum distribution systems.

C.1.2 Medical Gas and Vacuum Distribution System Information

Record the following information regarding the medical gas and vacuum distribution systems:

a) Location of the medical gas and vacuum source equipment
b) Location of the medical gas and vacuum zone valves
c) Location of the medical gas outlets and vacuum inlets
d) Location of medical gas and vacuum alarm panels
e) Location of the most remote medical gas outlet for each gas, for each zone
f) Location of the emergency oxygen supply connection (EOSC)
g) The test results for each of these gases in each zone that is tested

C.2 Test Equipment

C.2.1 Equipment Required:

a) Pressure gauge(s) / transducer(s): All pressure test gauges shall be clean for oxygen service. Test devices with a range of 700 kPa (100 psig) or less, for measurement ranges of 0 - 700 kPa (0 - 100 psig), shall have an accuracy of ± 7 kPa (±1.0 psig) or better.
b) Test devices with ranges up to 2000 kPa (300 psig), for measurement ranges of 700 - 2000 kPa (100 - 300 psig), shall have an accuracy of ± 20 kPa (± 3 psig) or better.
c) Vacuum gauge(s) / transducer(s): Test devices shall have a range of 0 to -760 mm (0 to -30 inches) of mercury and an accuracy of ± 25 mm (± 1 inch) of mercury.
d) Direct-reading flow meter(s) / flow sensor(s): All direct-reading flow meters/sensors shall have a rated accuracy of ± 3% (or better) of full scale reading of the gauge/indicator.
e) Adapters: Sufficient adapters shall be available to adapt the pressure gauge(s) / transducer(s) to each and every gas-specific medical gas outlet (and vacuum inlet). An additional set of quick-connect fittings may be used to quickly adapt the gauge/transducer to the gas-specific medical gas adapters.
f) Oxygen analyzer: Oxygen analyzers shall have a range of 0 - 100% and a rated accuracy of ± 1% oxygen or better.
g) Nitrous oxide: Nitrous oxide analyzers shall have a minimum range of 95 - 100% and a rated accuracy of ± 1% nitrous oxide or better. Instruments may be a pre-calibrated portable unit or laboratory instrument.
h) Nitrogen: Nitrogen analyzers shall have a minimum range of 95 - 100% and a rated accuracy of ± 1% nitrogen or better. Instruments may be a laboratory instrument.
i) Carbon dioxide
    1) Carbon dioxide analyzers for low level carbon dioxide shall have a range of at least 0 to 600 ppm and a rated accuracy of ± 10 ppm carbon dioxide or better. Instruments may be pre-calibrated portable unit(s) or laboratory instruments.
    2) Carbon dioxide analyzers for 99% or better carbon dioxide shall have a minimum range of 95 - 100% carbon dioxide and a rated accuracy of ± 3% carbon dioxide or better.

Instruments may be pre-calibrated portable unit(s) or laboratory instruments.

3) Carbon dioxide analyzers for carbon dioxide and oxygen mixtures shall have a range of 0 - 1% carbon dioxide greater than the maximum carbon dioxide level (e.g. 3% carbon dioxide - 97% oxygen requires a minimum range of 0-4% carbon dioxide). Rated accuracy shall be ± 3% carbon dioxide or better. Instruments may be pre-calibrated portable unit(s) or laboratory instruments.

j) Carbon monoxide: Carbon monoxide analyzers shall have a range of at least 0 to 20 ppm and a rated accuracy of ± 1 ppm of carbon monoxide or better. Instruments may be pre-calibrated portable unit(s) or laboratory instruments.

k) Analyzers for total hydrocarbons (as methane) shall have a range of at least 0 to 100 ppm and a rated accuracy of ± 1 ppm total hydrocarbons or better. Instruments may be pre-calibrated portable unit(s) or laboratory instruments.

l) Analyzers for halogenated hydrocarbons shall have a range of 0 to at least 5 ppm, and a rated accuracy of ± 1 ppm halogenated hydrocarbons or better. Instruments may be pre-calibrated portable unit(s) or laboratory instruments.

m) Dew point analyzers shall have a range of at least -40 °C (-40 °F) to 20 °C (68 °F) pressure dew point, but shall have a range of -60 °C (-76 °F) to 20 °C (68 °F) pressure dew point for desiccant dryers operating at lower than -40 °C (-40 °F) pressure dew point. Analyzer shall read within an accuracy of ± 3 °C (± 5 °F) (or better) pressure dew point and be able to sample pressure dew point at 345 kPa (50 psig). The dew point analyzer shall be calibrated in accordance with the manufacturer's recommendations.

n) Sample cylinders are needed only if remote laboratory analysis is employed.

o) Particulate sampling filter holder: A pressure-tight metal or plastic device that holds a filter element in the proper position for sampling. The filter holder shall be large enough to permit the flow of 100 LPM (3.5 SCFM) through the proper filter.

p) Disposable filters: Clean, environmentally stabilized, pre-weighed 0.45 micro filters.

q) Tweezers for handling filters.

r) Microbalance: Filter elements shall be pre-weighed on a microbalance accurate to within 0.1 milligrams.

s) Filter containers: Filter elements shall be saved in individual filter containers and stored to preserve the filters from further contamination.

t) Test equipment calibration requirements: Pressure and vacuum gauges/sensors, flow measuring devices, dew point analyzers and analytical balances shall be calibrated and traceable to the National Institute of Standards and Technology (NIST) at least annually. Each gas composition (% and ppm) analyzer shall be pre-calibrated and/or periodically calibrated as required/recommended by the analyzer manufacturer. Some gas analyzers may require periodic calibration by the manufacturer or other NIST traceable organization. Calibration shall be verified following any damage or suspected contamination that may affect the performance of any test device.

u) All test equipment shall be listed with model and serial numbers with calibration dates noted as requested.

C.3 General Requirements for Verification Tests

C.3.1 Purpose

The purpose of this section is to establish the general requirements for verification testing of medical gas and vacuum source equipment and distribution systems.

C.3.2 Requirements

The following verification tests shall be performed on all medical gas and vacuum distribution systems, using either nitrogen NF or the system gas.

a) Standing pressure and vacuum tests
b) Cross-connection test (by individual pressurization or pressure differential)
c) Shut-off valve test
d) Master alarm test
e) Area alarm test
f) Local alarm test
g) Piping purge test
h) Piping particulate test
i) Piping purity test
j) Final tie-in test
k) Operational pressure test
l) Medical gas concentration test
m) Medical air purity test for compressor systems
n) Labeling of system components
o) Medical gas supply source tests
p) Medical air compressor system tests
q) Medical/surgical vacuum systems tests

C.3.3 Test Gas

For small projects that involve a limited number of areas, where the use of nitrogen NF for testing is impractical, the system gas shall be permitted to be used for verification testing if approved by the Authority Having Jurisdiction (AHJ).

C.3.4 Manufactured Assemblies and Other Multiple-Outlet/Inlet Terminals

a) Where manufactured assemblies or other terminals are connected to the distribution system by means of flexible tubing or hoses, the outlets/inlets on the assembly or terminal shall be verified after installation and connection of the manufactured assembly.
b) Where terminals include multiple outlet/inlet connection points, each use connection point shall be verified separately.

C.4 Verification of Standing Pressure Test for Positive Pressure Gases

C.4.1 Purpose

The purpose of this section is to verify that the distribution piping for positive pressure medical gases is still free from leaks since being leak tested by the installer.

C.4.2 Requirement

The distribution piping system shall show no sign of leakage after being isolated for ten (10) minutes.

C.4.3 Procedure

a) Fill the system with nitrogen NF, or the system gas, to the normal system operating line pressure.
b) Close the source valve and all zone valves.
c) Verify that there is no decrease in pressure after ten (10) minutes at a point in each zone.
d) Record any areas of leakage.
e) The installer shall locate, repair or replace, and retest any leaks.
f) Repeat this standing pressure test as required.

C.5 Verification of Standing Vacuum Test for Vacuum Systems

C.5.1 Purpose

The purpose of this section is to verify that the distribution piping for medical vacuum systems is still free from leaks since being leak tested by the installer.

C.5.2 Procedure

a) Open the piping system to the vacuum source operating at the normal system vacuum level.
b) Close the source valve and all zone valves.
c) There shall be no indication of a drop in vacuum after ten (10) minutes at a point in each zone.
d) Record any areas of leakage.
e) The installer shall locate, repair or replace, and retest any leaks.
f) Repeat this standing vacuum test as required.

C.6 Verification Tests for Cross-Connections

C.6.1 Purpose

The purpose of this section is to verify that no cross-connections exist within any of the medical gas, instrument air, vacuum distribution and WAGD systems.

C.6.2 Requirement

Determine that there are no cross-connections between the station outlets and vacuum inlets. Verify that each outlet and inlet is connected to the proper piping system using either the individual pressurization method or the pressure differential method.

C.6.3 Procedure

a) Pressurizing one system at a time:
    1) Reduce the pressure of all medical gas systems (e.g. oxygen, medical air, medical vacuum, nitrous oxide, nitrogen, etc.) to atmospheric pressure.
    2) Pressurize one medical gas distribution system with nitrogen NF, or source gas where permitted, to 345 kPa (50 psig) gauge.
    3) With appropriate gas specific adapters matching the outlets, test and record the pressure at each individual station outlet and vacuum inlet. Only the outlets (or inlets) on the tested system shall read 345 kPa (50 psig). All other outlets (inlets) shall read 0 kPa (0 psig).
    4) Disconnect the test gas from the system just tested and reduce the pressure in the system to atmospheric.
    5) Proceed to test and record the results of each medical gas and vacuum system in accordance with steps 1, 2, 3 and 4 above, each time checking every outlet/inlet in every system.

b) Pressurizing all systems simultaneously at different pressures (pressure differential method):
   1) An alternate cross-connection verification test using a different pressure for each gas and vacuum piping system is permitted to be used in lieu of the individual pressurization procedure in C.6.3.a.
   2) The different gauge pressures shall be 140-210-275-345-415 kPa (20-30-40-50-60 psig) gauge, as defined in NFPA 99-2015.
   3) Where a system operates at a non-standard pressure, it shall be tested at a pressure that is at least 70 kPa (10 psig) gauge higher or lower than any other system being tested.
   4) When this pressure differential procedure is used, all pressure gauges used for the test shall be calibrated against the pressure indicator for the line pressure regulator that was used to set the test pressures. Any vacuum systems shall be in operation so that these vacuum systems are tested at the same time that the medical gas systems are tested.
   5) This alternate procedure is not permitted to be used by installers for the initial cross-connection tests in ASSE Standard 6010.

C.7 Verification of Shut-off Valves

C.7.1 Purpose

The purpose of this section is to verify that all shut-off valves in a medical gas and vacuum system function properly and are properly labeled.

C.7.2 Requirement

Each shut-off valve shall be labeled to identify the system and room or area that it controls.

C.7.3 Procedure

a) Zone Valves
   1) Close each zone valve and bleed gas or vacuum from an outlet/inlet in the room or area that its label indicates it serves.
   2) Verify that the valve controls all outlets/inlets in the room or area that its label indicates it serves by observing a decrease in pressure or vacuum at each outlet/inlet.
   3) Check adjacent zones to ensure that no loss of pressure or vacuum has occurred in other areas.

b) In-Line Shut-off Valves for Servicing Individual Rooms or Areas
   1) Close each in-line shut-off valve and bleed gas or vacuum from an outlet/inlet in the room or area that its label indicates it serves.
   2) Verify that the valve controls an outlet/inlet in the room or area that its label indicates it serves by observing a decrease in pressure or vacuum.

c) Service Valves for Lateral Branch Piping from Mains or Risers
   1) Close each service shut-off valve and bleed gas or vacuum from an outlet/inlet in the room or area that its label indicates it serves.
   2) Verify that the valve controls an outlet/inlet in the area or building that its label indicates it serves by observing a decrease in pressure or vacuum.

d) Riser Valves
   1) Close each riser shut-off valve and bleed gas or vacuum from an outlet/inlet off the riser that its label indicates it serves.
   2) Verify that the valve controls an outlet/inlet in the area or building that its label indicates it serves by observing a decrease in pressure or vacuum.

e) Main Line Valves (where provided)
   1) Close each main line shut-off valve and bleed gas or vacuum from an outlet/inlet in the building that its label indicates it serves.
   2) Verify that the valve controls an outlet/inlet in the building that its label indicates it serves by observing a decrease in pressure or vacuum.

f) Source Valves
   1) Close each source shut-off valve and bleed gas or vacuum from an outlet/inlet in the system that its label indicates it serves.
   2) Verify that the valve controls an outlet/inlet in the system that its label indicates it serves by observing a decrease in pressure or vacuum.

g) Records
   1) Record each shut-off valve and the building, area or room that it serves.

C.8 Verification of Master, Area and Local Alarms

C.8.1 Purpose

The purpose of this section is to verify that master, area and local alarm systems function properly and are properly labeled.

C.8.2 Requirement

Master, area and local alarms shall function as required by NFPA 99-2015.

C.8.3 Procedure

Refer to verification tests under C.9 through C.21.

C.9 Verification of Pressure/Vacuum Alarms

C.9.1 Purpose

The purpose of this section is to verify the operation of the pressure alarms in the medical gas and vacuum systems.

C.9.2 Requirement

a) Pressure alarm switches and transducers shall initiate an alarm on their respective master and area alarm panels whenever the line pressure is 20% above or 20% below the normal system pressure.
b) Vacuum alarm switches and transducers shall initiate an alarm on their respective master and area alarm panels whenever the vacuum falls below 300 mm (12 inches) Hg.

C.9.3 Pressure Alarms

a) Close the applicable source, main or area zone valve.
b) Increase the pressure in the piping system to the high-pressure alarm point (20% above the normal pressure).
c) Check the applicable master and area alarm panels to ensure that the properly labeled high pressure warning signal is activated – also check the mainline pressure gauge and area gauges to ensure that their pressure readings are within ± 20 kPa (± 3 psig) (or better) of the test pressure gauge.
d) Silence the audible signals. The visual signals should remain activated.
e) Reduce the piping system pressure to normal.
f) Check the applicable master and area alarm panels for deactivation of the alarm signals.
g) Continue the flow from the system until pressure is reduced to the low pressure alarm point (20% below normal).
h) Check the applicable master and area alarm panels for activation of the properly labeled warning.
i) Check the applicable mainline pressure gauge and area pressure gauges to ensure their function and accuracy.
j) Silence the audible signals. The visual signals should remain activated.
k) Open the applicable shut-off valve.
l) Check applicable master and area alarm panels for deactivation of the alarm signals.
m) Disconnect the wiring from the pressure alarm switches and/or transducers to the master and/or applicable area alarm panels and check for alarm signals. Reconnect the wiring and check that the alarms deactivate.

C.9.4 Vacuum Alarms

a) Close the main, source or area zone shut-off valve.
b) Decrease the vacuum in the piping system to less than 300 mm (12 inches) of mercury.
c) Check the applicable master and area alarm panels to ensure that the properly labeled low vacuum warning signal is activated. Also check the applicable mainline vacuum gauges and area gauges to ensure that their pressure readings are within ± 25 mm (1 inch) of mercury of the test pressure gauge.
d) Silence the audible signals. The visual signals shall remain activated.
e) Open the applicable shut-off valve. Increase the piping system vacuum to normal.
f) Check the applicable master and area alarm panels for deactivation of the signals.

C.10 Piping Purge

C.10.1 Purpose

The purpose of this section is to purge particulate matter from all positive-pressure pipelines after construction.

C.10.2 Requirement

a) Each outlet shall be purged with a heavy, intermittent flow of gas.
b) No pronounced or objectionable odor from any positive pressure outlet.

C.10.3 Procedure

a) Initiate a heavy 225 LPM (8 SCFM) purge of the pipeline without the filter holder attached to the medical gas outlet adapter. Each new outlet within the facility shall be purged in this manner. After the purge is started, it shall be interrupted several times until the purge produces no discoloration on a white cloth loosely held over the adapter during the purge.
b) Positive pressure medical gas outlets contain two (2) valves: a primary valve that can be removed for repair, and a secondary valve that is installed behind the primary valve and is closed only when the primary valve is removed for repair. If large amounts of contamination are found in the area or zone, the removal of both the primary and secondary valves may be required to effectively purge the contamination from the affected line.