4.4 MEDICAL GAS RISERS

Medical gas risers may be installed in pipeline shafts if suitable protection against physical damage, effects of excessive heat, corrosion or contact with oil is provided.

NOTE: During installation all pipeline fittings, manifolds and terminal equipment should be identified to ensure identification is maintained either permanently or temporarily, but otherwise in accordance with Clause 3.6.

4.5 RISERS AND DROPPERS TO TERMINAL UNITS

The minimum outside diameter of any dropper or riser line shall be 12 mm. The minimum outside diameter for copper pipes for suction shall be 18 mm.

4.6 SLEEVES

Where pipelines pass through masonry walls, partitions or floors, such pipelines should be fitted with protective copper sleeves and provided with appropriate wall or ceiling plates, fire-stopped if necessary.

4.7 CONTACT WITH CORROSIVE MATERIALS

The pipeline shall be protected from chemical and electrolytic corrosion, where appropriate.

4.8 ROUTING

A pipeline for medical air shall be routed in such a way that it is not subjected to a temperature below the dewpoint of the gas it carries.

4.9 CUTTING INTO AN EXISTING SYSTEM

Cutting into an existing system should be carried out with a radial pipe cutter or similar tool which does not produce cuttings or filings.

To prevent carry-over of particulate matter from old pipelines into new extensions, a non-ferrous metal-body filter, having a sintered bronze element of size not more than 10 µm should be installed in the branch feeding the new pipeline. Such a filter or parallel filters should be required only when the calculated increase in peak flow exceeds 40% of the previous estimated or measured peak flow (whichever is the lesser). Where installed, all components of the filter shall be compatible with oxygen and the filter assembly shall be sized to 140% of the designed peak flow.

NOTE: Scale in old pipelines and an increase in gas velocity in the old pipeline because of the new extension is likely to shift debris down the pipeline and block or damage terminal units or equipment. For this reason, a filter is required.

4.10 INTERCONNECTION

No two medical gas piping systems containing different gases or the same gas at different supply pressures shall be interconnected. If two sources of the same gas, supply the same system, each shall be connected through a non-return valve at the junction of the source of supply and the pipeline.

4.11 PIPELINE SUPPORTS

Medical gas pipelines shall be supported at intervals sufficient to prevent sagging or distortion in accordance with Table 4.1. Supports shall be of proper strength so that the pipeline cannot be moved accidentally from its position. Supports shall be constructed of metal and made so that they are corrosion resistant. For this purpose, they may be treated or sleeved. The support shall not corrode the pipeline.

Medical gas pipelines shall not be used as a support for any other pipelines, including medical gas pipelines or conduits. However, a common support bracket of sufficient strength is permitted to independently support each medical gas pipeline. U-bolt pipe supports shall not be used.

Where vertical pipes are exposed in rooms, they shall be secured at floor and ceiling; pipes up to 25 mm shall have at least two intermediate supports.

TABLE 4.1

MAXIMUM SPACING FOR BRACKETS AND CLIPS

Nominal pipe size DN	Maximum horizontal spacing (m)	Maximum vertical spacing (m)
15	1.5	1.8
20	1.5	2
25	2	2.5
32	2.5	2.5
40	2.5	3
50	3	3
65	3	3.5
80	3	3.5
100	3	4
150	3	4
200	3	4
250	3	4

NOTE: These maximum spacing dimensions are from AS 4809-2003, Table 6.2

4.12 COPPER PIPELINE JOINTS

4.12.1 Brazing

All welded joints shall be brazed in accordance with Appendix G.

4.12.2 Threaded and flange joints

Threaded and flange joints may be used on components such as valves, pressure protection and measuring devices, pressure gauges and filters. Where used, these shall be one of the following:

(a) Compression fittings of the double slip-ring type. Single olives shall not be used.

(b) Oil-free polytetrafluoroethylene (PTFE) tape, suitable for use with oxygen, applied to the threaded joints.

(c) Tinned screwed joints.

(d) Flanges, in accordance with AS 4041.

(e) Flared copper joints.

Copper alloy pipe fittings shall be manufactured in accordance with AS 3688 and be of the silver brazed type.

NOTE: Flange joints are not a preferred method of connection unless necessary for electrical isolation or for section removal.

4.12.3 Brazing alloy

All brazing alloys used in the fabrication of pipes and fittings shall comply with B4 alloy designation as specified in AS/NZS 1167.1. Flux shall not be used on-site. For off-site applications, brazing shall be performed as outlined in Appendix G. During brazing operations, commercial-grade carbon dioxide shall be used as an internal inert gas shield.

4.13 CONNECTION TO EXISTING SYSTEMS

4.13.1 General

Connections to existing systems shall be undertaken in only one gas system at a time to minimize the risk of cross-connection.

NOTE: Before any work commences on an alteration or extension to an existing pipeline system, every area involved should be advised by a written 'permit to work'. An example of such advice is given in Figure H8.

4.13.2 Installation of an additional pipeline

Where an addition is made to an existing system, the new pipeline shall have an air-break during construction, with the existing system. When the construction of the addition has been completed and pressure tested (in accordance with Section 5), the addition should be connected to the existing system through an isolation valve. Where present, the isolation valve shall be secured in the open position and the 'Construction .....' label removed; the valve shall then be clearly identified in accordance with Clause 3.4.2.3. Terminal units shall have their 'do not use' labels removed.

If there is no downstream monitoring of the pressure in the additional pipeline, then, after construction, the construction isolation valve shall be permanently disabled in the open position or locked in the normal operating position and labelled.

4.13.3 Sealing and labelling of isolating valve

An isolating valve required by Clause 4.13.2 shall be sealed in the closed position during construction and labelled 'Construction isolation valve—Do not open'. The risk of unauthorized opening may be minimized by removal of the hand-wheel or by wiring.

4.13.4 Marking of affected terminal units

All sections of the system downstream of the point of connection shall be taken out of service and all affected terminal units marked to indicate they cannot be used (see Clause 5.3).

4.13.5 Testing for leaks after addition to the system

When pressure tests of the addition have been completed, connection may be made to the existing system and this connection itself tested for leaks.

NOTE: Careful consideration should be given to the siting of this connection to minimize problems of access in installation and testing.

4.14 FIXED SECONDARY EQUIPMENT

4.14.1 General

The primary function of fixed secondary equipment is to allow placement of services safely and more conveniently in the work area.

4.14.2 Common requirements of all fixed secondary equipment

4.14.2.1 *Arrangement of services*

Each type of service shall be arranged so that a leak from any gas supply shall not cause a build-up of pressure within the fixed secondary equipment structure.

4.14.2.2 *Electrical services*

All electrical services shall be installed and fitted in accordance with the requirements of AS/NZS 3000 and AS/NZS 3003. General purpose outlets (GPOs) shall be positioned with their face plane on or between the vertical and 60 degrees, facing down.

NOTE: Spacing of GPOs should not be less than 60 mm between centres to allow for side entry plugs and transformer packs. For cardiac protected areas, if the equipotential terminal studs are below a GPO, the studs should be at least 100 mm below the earth connection of the GPO and horizontally offset.

Electrical services shall be so arranged that sparking or heating of cabling or equipment shall not affect any gas, extra-low voltage or communications services.

Electrical segregation from other services shall be maintained within the fixed secondary equipment and different services shall not share common service outlet boxes.

All metal fittings or parts of fixed secondary equipment shall be earthed in accordance with AS/NZS 3003.

4.14.2.3 *Gas services*

Piped connections to the terminal units in fixed secondary equipment may be made using either copper pipe or flexible hoses.

Copper pipeline joints shall be in accordance with Clause 4.12.

Flexible hoses shall be fitted with non-field-replaceable NIST connectors on both ends in accordance with ISO 5359, but excluding the necessity for a self-sealing device. The matching gas specific half connectors shall be brazed or similarly permanently attached to the pipeline and to the terminal unit(s). The hose shall be permanently attached (i.e. the fitting can be dismantled only by being destroyed) to the NIST fitting by means of a swaged ferrule or similar device. The ferrule shall be fitted by the use of a special purpose tool. The attachment shall not be made by crimped clips or clamps. NIST fittings for venturi suction exhausts are not required.

NOTES:

1 Flexible hoses should be coloured (in accordance with Table 3.2). Hoses should be diameter differentiated.

2 Venturi suction exhaust is not required to have a NIST fitting.

3 The use of a NIST connection to the tail of the terminal unit in fixed secondary equipment is intended to facilitate service and maintenance.

The hose material shall be compatible with the appropriate gas, and suitable for continuous use at the operating pressures detailed in Section 5. In operation, the hose shall not kink or flatten.

NOTE: Compatibility with nitrous oxide and carbon dioxide may be a particular problem as leaching of plasticizers may occur.

After installation of the fixed secondary equipment and connection to the pipeline system, all terminal units fitted shall be tested in accordance with Section 5. The tests specified in Clause 5.5 shall be carried out following any fitting of, or repairs to, terminal units where a break-in to a gas pipeline or hose has occurred.

Terminal units for all gases including vacuum shall be positioned so that the open long axis of the outlet is not above the horizontal.

For surgical tool air, the NIST connector shall be A-6 in ISO 5359.

4.14.2.4 *Communication and monitoring links*

Service cabling and equipment shall be electrically and physically segregated from gas and mains electrical services.

4.14.2.5 *Construction*

Fixed secondary equipment should be designed and constructed to include the following features:

(a) Ready access to components requiring routine maintenance.

(b) Generally be of smooth finish for ease of cleaning.

(c) Be constructed of materials and finishes which will resist the cleaning agents used in health care facilities and have good corrosion resistance.

(d) Be ergonomically suitable both in design, and in placement of services, for their intended application.

4.14.3 Specific requirements of pendants and booms

Support bases shall be designed for the gross loads imposed by the pendant or boom and anchored to the building structure.

NOTE: Gross loads include the static dead weight of the pendant or boom, associated dynamic forces, and any ancillary equipment (e.g. monitors) that may be fitted. To comply with this Clause, certification by an engineer may be required.

Pendants and booms shall be installed so that all vertical and horizontal axes are true and plumb. Where the design includes moveable arms or service heads, these arms or service heads shall not creep after positioning.

Pendants and booms that use either pneumatic or electric power to accomplish movement or to operate brakes shall not move down in the event of loss of power.

Adjustment of the pendant or boom shall not lead to the sound pressure level within the area being raised by more than 4 dB(A) above the ambient sound pressure level.

Pendants and booms that incorporate in their design a table or platform to support equipment (e.g. monitors) shall have fixed a label clearly stating the working load limit in kilograms. Fixed secondary equipment with a table or platform shall be tested using a force of 1.5 times the working load limit and there shall be no creep or deflection of any pendant or boom structural component or their support bases.

Pendants and booms designed for vertical positioning of the services head shall have a minimum movement of 500 mm.

Pendants and booms having moveable arms or moveable service heads (or both) shall have limit stops fitted to prevent lateral rotation exceeding 360 degrees. When the arms or service heads are positioned against any limit stop, no movement beyond the stop nor damage to the stop or components shall occur when a tangential force of 200 N is applied at the component's maximum moment for 10 s.

All limit stops shall be set in their final position before testing and certification in accordance with Clause 5.5.

The non-moving parts of a pendant or boom shall have a minimum clearance of 1.9 m with the floor.

Where pipeline supply services more than one patient, service valves specific to the pendant or boom, located in the false ceiling, adjacent to the access panel, shall be installed to enable servicing of a pendant by authorized personnel only, without disruption to other areas.

NOTE: For the purposes of this Clause, the induction room and operating theatre are considered a single patient location.

Where an oxygen service is fitted, at least one oxygen terminal unit shall be fitted having its long axis horizontal to allow attachment of a floating-ball flowmeter.

Pendants and booms, which have a base higher than 1.5 m in any position, should be designed with smooth blunt surfaces. Where this is not possible, a smooth protective rigid buffer of at least 15 mm width and having blunt edges shall be sited beyond the protrusion(s) at a level within 30 mm of the base of the pendant or boom.

NOTE: With SIS fittings intended for attachment of flow meters and suction units, the guard should extend sufficiently to include the likely attachments within its perimeter.

4.14.4 Specific requirements of columns and pedestals

Columns and pedestals should be positioned in the room at least 1000 mm from any wall or barrier.

Columns shall be securely anchored to both the floor and ceiling and be of sufficient structural strength to withstand impact from items such as trolleys and beds.

Pedestals shall be securely anchored to the floor and be of sufficient structural strength to withstand impact from items such as trolleys and beds.

Particular attention should be given to the provision of means to prevent water from entering the base of columns and especially pedestals, which will most likely have the service piping and cabling entering through the floor.

Where an oxygen service is fitted, at least one oxygen terminal unit shall be fitted having its long axis horizontal to allow attachment of a floating-ball flowmeter.

4.14.5 Specific requirements of wall ducting

Wall ducting, whether of vertical or horizontal configuration, shall be securely anchored to the wall and be of sufficient strength to support any ancillary fitted equipment such as reading/examination lights and gas therapy apparatus.

Where an oxygen service is fitted, at least one oxygen terminal unit shall be fitted having its long axis horizontal to allow attachment of a floating-ball flowmeter.

SECTION 5 TESTING AND CERTIFICATION

5.1 GENERAL

The following tests shall be carried out:

(a) Visual check (see Clause 5.4.2).

(b) Initial pressure test (see Clause 5.4.3).

(c) Check for valve tightness and correct zoning (see Clause 5.4.4).

(d) Check for particulate matter (see Clause 5.4.5).

(e) Check for cross-connection in pipeline (see Clause 5.4.6).

(f) Total system pressure test (see Clause 5.5.2).

(g) Check for flow rate and pressure at terminal units (see Clause 5.5.3.1).

(h) Check for total flow rate and delivery pressure (see Clause 5.5.3.2).

(i) Check for operation of all supply plant functions (see Clause 5.6.3).

(j) Check for performance of alarm systems (see Clause 5.6.4).

(k) Check for gas concentration (see Clause 5.6.5.2).

(l) Check for odour (see Clause 5.6.5.3).

(m) Confirm that the medical air as supplied by a compressor is in accordance with AS 2568.

The importance of proper testing and commissioning of medical gas systems cannot be over-emphasized and all the tests defined in this Clause shall be performed.

NOTES:

1 Appendix H outlines a logistic diagram, test certificates, nonconformance reporting and contract completion certificate for testing of the pipeline system. Appendix I provides an example of documenting and recording testing of terminal units.

2 Only complete testing can reduce to a minimum the risks of cross-connection, contamination or failure of supply.

5.2 TESTING, VERIFICATION AND CERTIFICATION

The representative of the health care facility shall designate competent person or persons to carry out the tests specified in Clause 5.1. Such a person shall certify to the administration that the results of tests are in accordance with the standard. The designated person or persons shall be competent in medical gas testing and verification of piping systems.

With cross-connection testing, a member of the health care facility shall be present to verify the testing. This testing may be carried out in conjunction with the operational test (see Clause 5.7.1).

NOTE: In large installations it may be necessary for individual tests to be carried out at different times.

All instruments shall have been calibrated within the previous 12 months, or lesser period if recommended by the instrument manufacturer.

Accuracy ratings for pressure gauges shall be ±2% of full scale deflection or better. Flow meters shall be ±5% of full scale or better.

5.3 LABELLING OF TERMINAL UNITS

In an occupied building, before any testing is carried out, every terminal unit subject to test shall be labelled to indicate that the system is under test and that it shall not be used (see Clause 4.13.4).

5.4 TESTS AND CHECKS ON PIPELINE BEFORE CONCEALMENT

5.4.1 General

All tests specified in this Clause may be performed using carbon dioxide as the test gas. In the event of a leak or cross-connection being found, the carbon dioxide shield gas will already be in the pipeline allowing repairs to be effected easily. If air has been used as the test gas and a fault is discovered, the air shall be purged from the pipeline and the requirements of Clause 4.12.3 shall be met.

NOTE: CO_2 accumulation can endanger those in the area. Care should be exercised in the venting of CO_2 and the work should be performed under good ventilation conditions to avoid the installer being exposed to a lack of oxygen (see Appendix G, Clause G2).

5.4.2 Visual check

Visually check that the identification requirements of Clause 3.6 have been met and the requirements of Section 4 have been observed.

NOTE: The information contained in Appendix F should also be taken into account.

5.4.3 Initial pressure test

After installation of terminal units, but before the wall is closed in, each section of the piping system shall be subjected to a pressure test by the installer in accordance with the following test pressures:

NOTE: Users of this Standard are advised that, in some cases, manufacturers provide special test plugs with their terminal units. These test plugs make possible the performance of specified pressure tests without terminal units having to be completely assembled (i.e. installed). Such terminal units are considered to be 'installed'.

(a) *Medical gas pipeline (oxygen, nitrous oxide, medical air)* This pipeline shall be tested at 620 kPa and the only allowable pressure change in a 4 h period shall be that caused by variations in the ambient temperature around the pipeline system (see Appendix J).

(b) *Surgical tool air pipeline* This pipeline shall be tested at 1800 kPa and the only allowable pressure change in a 4 h period shall be that caused by variations in the ambient temperature around the pipeline system (see Appendix J).

(c) *Vacuum pipeline* This pipeline shall be tested at 140 kPa and the only allowable pressure change in a 4 h period shall be that caused by variations in the ambient temperature around the pipeline system (see Appendix K).

NOTE: Testing a vacuum pipeline under vacuum is not current practice because fault detection is difficult.

Hydraulic testing shall not be used.

During these tests any equipment such as suction switches, suction gauges, pressure switches, pressure gauges and regulators that may be damaged or are unsuitable for the test pressure shall be removed or isolated from the system.

During these tests, vacuum plants, compressed air plants, liquid oxygen supply plants and cylinder supply manifolds shall not be connected to the pipelines under test.

All zone isolation valves shall be open.

5.4.4 Zone isolation valve tests

On completion of the pressure tests specified in Clause 5.4.3, each zone isolation valve shall be tested for shut-off. Using the test pressures specified in Clause 5.4.3 the system shall be pressurized with the valve open. The valve shall then be closed and the downstream pressure dropped to 70 kPa. There shall be no increase in the downstream pressure after 15 min.

At the same time as the test is conducted, each valve shall be checked to ensure it isolates the area defined, and only that area, and that the valve conforms to Clause 3.4.

5.4.5 Particulate matter tests

Each pipeline system shall be tested for the presence of particulate matter. The test shall be carried out at each terminal outlet during the purity testing of the medical gas pipeline.

The flow rate for the test shall be 150 L/min for a period of not less than 30 s. The test shall be carried out using a calibrated orifice connected to a disposable paper element, which shall be inspected after each outlet has been tested. The paper element shall be white in colour and have a maximum pore size of 5 µm. The paper element holder shall have provision to vent waste gases to a safe location.

If any discolouration of particulates are found on the test paper, the pipeline in the local area shall be closed off and the system fully purged until such time as the local area has been retested and passed. Any test papers that show discolouration shall be kept for future reference. Details of the date, location and witnesses shall be recorded and shall form part of the commissioning documentation.

5.4.6 Test for cross-connections

5.4.6.1 *In a piping system installed from source to terminal units*

Testing for cross-connections in a piping system installed from source to terminal units complete, shall be in accordance with the following:

(a) Pressure in all piping systems other than the one under investigation shall be reduced to atmospheric and monitored.

(b) All zone isolation valves in all systems shall be open.

(c) Pressure in the piping system under investigation shall be raised to the following pressures:

  (i) 410 kPa for medical gas and surgical tool gas pipelines.

  (ii) 140 kPa for vacuum pipeline.

(d) Each individual terminal unit of each piping system shall be checked to determine that the test gas is being dispensed only from the terminal units of the system under investigation.

Steps (a) to (d) shall be repeated for each system in turn.

5.4.6.2 *In a piping system which is an addition to an existing system*

Testing for cross-connections in a piping system which is an addition to an existing system will not normally require all terminal units to be checked as required in Clause 5.4.6.1. The following procedure shall be carried out as a minimum requirement:

(a) If a single service is being extended from a point where no other services are run, no test for cross-connection need be made.

(b) If other services are adjacent to the point of connection, or if more than one service is being extended, then zone isolation valves on all services upstream of all points of connection shall be shut off and testing shall proceed in accordance with Clause 5.4.6.1, Steps (a) to (d).

NOTE: Additions and modifications to existing pipeline systems usually involve some disruption of the existing supply of gases. The implementation of such disruptions should be preceded with appropriate warnings to all appropriate areas of the health care facility. Thus extreme care should be taken to advise the appropriate personnel, e.g. medical staff, nursing staff and engineering staff, of the duration and type of interruption or disruption. One system for achieving this is through a 'Permit to Work' system (Refer to Figure H8 Form T7 Permit to work).

5.5 TESTS AND COMMISSIONING OF THE COMPLETE PIPELINE SYSTEM

5.5.1 General

The tests specified in Clauses 5.5.2 and 5.5.3 shall be performed at nominal design working pressures. The tests should use cylinder medical air for the oxygen, nitrous oxide and surgical tool air systems. The medical air system, including air-actuated venturi suction, may be tested using the medical compressed air plant provided that satisfactory air quality tests in accordance with AS 2568 have been performed on the plant.

The vacuum system shall be tested using the vacuum plant.

5.5.2 Pressure test

With all terminal outlets fully assembled and all pressure switches, safety valves and gauges installed, the pressure systems shall be set at their respective nominal working pressures and the only allowable pressure change in a 4 h period shall be that caused by variations in the ambient temperature around the pipeline system (see Appendix J).

During this test, the test gas shall be isolated from the system after pressurizing the system under test.

The vacuum system shall be set to −60 kPa and the pressure increase shall not exceed 10 kPa per hour.

NOTE: In tests where large volume systems are involved, it may be preferable to test small sections of the system individually.

5.5.3 Tests for flow rate and pressure

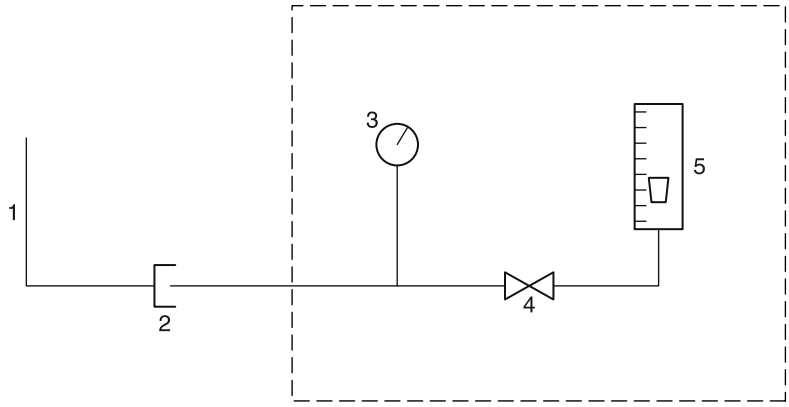
5.5.3.1 *Installed terminal unit flow test*

Tests shall be conducted in turn at each terminal unit to verify that the performance is in accordance with Table 5.1, Column 4. These tests shall be carried out as follows, using the method described below and the devices shown in Figure 5.1.

(a) Apply the device to the terminal unit with valve 4 closed and read the static pressure on gauge 3. This shall be in the ranges as outlined in Clause 3.3.2.

(b) Open valve 4 until a flow rate as per Column 3 of Table 5.1 is obtained and while at this flow rate, check the pressure on gauge 3. The difference between this reading and the static pressure shall not exceed that shown in Column 4 of Table 5.1.

The flow at each terminal unit for medical suction shall not be less than 40 L/min with a static negative pressure of at least −60 kPa.



LEGEND:

1 = Pipeline dropper
2 = Terminal unit
3 = Pressure gauge
4 = Flow control valve
5 = Flowmeter (or calibrated orifice)

FIGURE 5.1 TEST DEVICE

5.5.3.2 *Pipeline distribution system flow test*

Tests shall be carried out in all principal areas of the health care facility to verify that the performance is in accordance with Table 5.1, Column 5. These tests shall be carried out using the following method, and the devices shown in Figure 5.2:

(a) Attach pressure gauge 6 to the most remote terminal unit 4 on the line within the test area and read the static pressure. This shall be in the ranges as outlined in Clause 3.3.2.

(b) Using calibrated orifice plates or flow gauges with control valves 5, release gas at a set flow rate from other terminal units equivalent to the design demand calculated for the area. During this release, read the pressure at gauge 6. The difference between this reading and that taken in Step (a) shall not exceed that shown in Column 5 of Table 5.1.

NOTE: For large systems which require high flows it may not be possible to carry out this test, e.g. when the design flow rate for the pipeline system exceeds the plant design flow rate. Calculations proving the system design is capable of supplying the design flow rate for these areas may be accepted as a suitable alternative.

Calculation methods for pressure drops and pipe sizes, including software, may be used as long as validated methods and formulae, e.g. Colebrook Equation combined with Darcy/Weisbach formula, are used to obtain these results, and complete data records are kept confirming that pipe sizes and pressure drops are within the specified limits.

For local areas it is recommended that flow tests be carried out and test data be recorded. Flow calculations should be completed prior to these tests to confirm that no excess demand on the new systems may interrupt flows to existing health care facilities.

The pressure for medical suction during the diversified flow rate for an area, measured at the most remote terminal unit, shall not be more positive than –55 kPa.

NOTES:

1 For suction systems, the test should be conducted over at least one cycle of the suction plant.

2 For venturi systems using air for breathing, the suction and breathing air systems should both have the diversified load applied simultaneously.

3 Appendix B gives guidelines to help determine the design flow for pipelines and for plant sizing.