TRIPLE 'M'
GROUP OF COMPANIES
'the team you can trust'

AS 2896-2011 Changes from previous version published in 1986

Points of discussion where changes have occurred

Any Sections, clauses Headings not mentioned have had no changes or any changes are of such a minor nature that they do not make any changes to the way the Standard affects the design and installation of the medical gases installation.

The major alterations that have been included in this revision are

1) References to Authorized Bodies and documents such as the TGA and the Dangerous Goods Regulations
2) Provision of emergency gas supply for critical care locations
3) Tightening up the uses of medical air for alternative applications
4) Addition of greater levels of filtration for Medical Air systems
5) Expansion of Medical Air compressor plant details for installation.
6) Allowing the Medical Air to be used to control fixed secondary equipment for braking and pneumatic controls
7) Greater details for the installation of bulk liquid oxygen installations
8) Additional details about the use of VSD controls on vacuum pumps
9) New schematic drawing for vacuum systems
10) Alteration of Surgical Tool Air supplies to 1,200 kPa working pressure
11) Alteration to the design flow rate for Surgical Tool Air to 350 l/minute
12) Acceptance of oil flooded screw compressors for the manufacture of Surgical Tool Air
13) Alteration to the Medical Gas Alarms to include ALL Anaesthetizing locations.
14) Inclusion of 3 way valve and pressure switch in valve boxes
15) Clause referencing Quick connectors for medical gas terminal units has been deleted.
16) Greater details on the installation of venturi suction systems particularly regarding exhaust systems
17) Clarification on the use of isolation valves on supply pipelines to fixed secondary equipment in multi bed wards
18) Alterations to gases flow rates in the Appendices
19) Test equipment must have proof of currency of test.
20) Particulate Matter test detail has been added
21) Inclusion of formula for design of medical gas pipelines
22) Acceptance of design calculations as proof of flow rate design.
23) Changes to acceptance levels of gas purity during testing and commissioning.

Highlighted comments are explanations of how the various clauses have been changed and how this will affect the way in which the design and installation is carried out.

1) **CONTENTS**
   a. SECTION 2,
      i. Clause 2.2 Source of Supply, previously incorporated in 2.1, no impact, for information only
      ii. Medical Breathing Air replaced by Medical Air, this is global throughout the document
      iii. Clause 2.11 NEW
         1 Air for Surgical Tools
            a. Diversity on 0.2 which should read 100% for 1 and 0.2 for the balance. References cylinders and compressors.
   b. SECTION 6.
      i. Clause 6.8
         1 New Clause that references Low Pressure Hose assemblies, specifically refers to annual testing.
   c. APPENDICES
      i. Clause "E" changed from "experience of installer" to "competence of installer"
2) **FOREWARD**
   a. New sentence starting with "Medical Gas Pipelines are life support systems etc etc. refers to the safety aspects of the inherent problems associated with medical gas pipelines and some of the issues that arise
   b. Adds "Nitrous Oxide" into end of paragraph 1

3) **SECTION 1 SCOPE & GENERAL**
   a. 1.1 Scope, NEW note 2
      i. References TGA and other bodies that may have document superiority over this document.

NB The TGA has a ruling that states that if any medical gas installation complies with the requirements of AS 2896 it is not classified as a medical device and as such does not need TGA Registration. Any designs that are outside this ruling require appropriate registration. Government legislation be it State or Federal over rides this document. E.g. The Dangerous Goods Registration is Law and takes precedence. The DGR references AS 1894 and that elevates that Standard to a similar status. Some parts of this Standard are also referenced in the DGR and as such are also recognized as legislation.

   b. 1.2 APPLICATION. New gases included specifically
      i. CO2 mixes limited to less than 7%
      ii. Helium/Oxygen mixtures
      iii. Carbon Dioxide
   c. 1.4.4 COLUMN,
      i. Clause rewritten however does not change in essence
      ii. Now includes mobile booms
   d. 1.4.5 CONNECTOR
      i. Clause rewritten however does not change in essence it is somewhat vague now, could be confused with 1.4.7.
   e. 1.4.7 COUPLER
      i. NEW definition similar to 1.4.5, could cloud issues
   f. 1.4.10 EMERGENCY GAS SUPPLY
         1 This Clause has been revised and no longer gives specific details of the method of supply for this connection.

E.g. it no longer nominates that a cylinder supply should have a portion of the reserve bank of cylinders arranged as an emergency supply that can be monitored. NB This has never been done in Aus as manifolds do not operate in the same manner as European manifolds.

ii. 1.4.12 EMERGENCY POWER SUPPLY
    1 Details improved about how this is to be achieved.

NB This clause accepts that a minor break in power supply is acceptable, this should be taken into consideration if the equipment being connected uses any form of non permanent memory that needs to be retained, if this is the case a non interruptible power supply will be necessary.

iii. 1.4.14 FERRULES
    1 Details of hose connections, could be confused with 1.4.17 HOSE
iv. 1.4.15 HOSE INSERTS
    1 Old Clause deleted, no impact
v. 1.4.17 HOSE
    1 NEW, references Colour Code for hoses

NB This will affect the manufacturers of equipment that have flexible hoses built into their equipment. E.G. Pendants and Booms.

vi. 1.4.18 HOSPITAL ACCREDITED REPRESENTATIVE
    1 Clause rewritten however has no impact
vii. 1.4.21 MEDICAL AIR
    1 NEW references AS 2568 Purity of Medical Air

NB AS 2568 is the Standard that details the levels of gases and vapours that make up Medical Air and what levels are acceptable

viii. 1.4.22 MEDICAL AIR COMPRESSOR SYSTEM
    1 NEW definition of medical air system in two lines, simple generic description only.
ix. 1.4.37 SLEEVE INDEX SYSTEM
    1 NEW description of SIS connections

NB Description of the Australian type of collar system used to prevent cross connection of specific gas hoses for low pressure use.

x. 1.4.38 SUORCE OF GAS SUPPLY
    1 Rewritten previously 1.4.35, fundamentally the same

4) <u>SECTION 2 SOURCE OF SUPPLY</u>

a. 2.1 GENERAL
    i. This Clause has been substantially rewritten to provide options by the use of alternatives if it can be proved that they provide improved safety. Documentary proof must be provided by the proposer to the Health Care Facility to confirm this. Depending on the influence on the medical gases design this may need TGA registration.

NB This clause allows the system designer or installer the opportunity to provide alternative equipment that will enhance the level of safety or performance of the system. This may be the use of new technology or equipment that was not available at the time that this Standard was written. Proof that the alteration must be provided to the Health Care Facility to confirm this.

b. 2.2 SOURCE OF SUPPLY
   i. NEW previously part of 2.1, this Clause now provides a general description of supply plant only. The majority of the previous Clause 2.2 is now included in 2.3 PROVISION IN CASE OF FAILURE
c. 2.3 PROVISION IN CASE OF FAILURE
   i. This Clause now contains much of what was previously included in 2.2.

NB There is no impact in the two above alterations

d. 2.4.2 MANIFOLD
   i. NEW, Includes extensive new material regarding Oxygen compatibility for manifolds,

NB This could be at the detriment of gases such as CO2 and N2O which have different requirements that are not always compatible with Oxygen, E.G. Viton is not compatible with CO2 or N2O at high pressures.

e. 2.4.9 CYLINDER LEAD
   i. Non metallic leads are only acceptable for CO2,

NB This will ensure that Cylinder pack leads are now manufactured from copper only.

f. 2.4.10 EMERGENCY GAS SUPPLY
   i. <u>This incorporates one of the major alterations to the standard;</u>

NB This alteration provides details of the emergency gas supply that is used in special care locations. The use of multi cylinder manual or automatic manifolds is detailed in schematic Fig 2.3 Service/Emergency Facility. Number of cylinders is to suit supplier's ability to replenish within a reasonable time frame.

g. 2.5 PRESSURE REGULATORS (Pressure included in title)
   i. References to flows and heating as required to prevent condensation at manifold regulators.

NB This may be applicable in large installations with flow rates that have a refrigeration effect on the manifold regulators, this is of particular concern with N2O and CO2 manifolds

h. 2.8.3 EMERGENCY SUPPLY
   i. References that a 24 hr supply is the minimum required and that there shall be a 25% level alarm (previously 30%)

NB This level of alarm is particularly related to Liquid Oxygen vessels, the actual alarm switching is part of the vessel construction and is under the direct control of the gas supplier (these vessels are rented from the gas suppliers and the pipeline installer has no control of this) Connection of these alarms is usually part of the medical gas installers contract, they are interconnected with the medical gas alarm system and may also be supplied via a gateway to the building BMS system. There are three alarms that are supplied from the gas companies equipment, this one, the Emergency Supply Low and Oxygen Supply Failure.

5) 2.9 MEDICAL AIR SYSTEM (name changed from Medical Breathing Air System)
   a. 2.9,1 GENERAL

i. The Clause now contains specific information allowing the use of medical air to power ceiling columns, gas scavenging or for testing and drying of medical devices.
ii. It requires the use of a back flow prevention device and allows a maximum 10 l/min flow rate.
iii. A list of non acceptable uses for medical air is also provided.

NB ISO 7396 Medical Gases Standard has recently excluded the use of Medical Gases for the production of Ozone for clinical use which was being pursued by the Ozone equipment manufacturers. Independent supplies are now required for this purpose.

b. 2.9.2.3 Air Receivers
   i. The previous Clause relating to the sizing of receivers being relative to the design flow rate of the system has been deleted.

NB It is the responsibility of the designers to calculate the capacity of these vessels.

c. 2.9.2.4 AIR DRYNESS
   i. This Clause has changed the temperature of the Pressure Dew Point from 2 to 5 degrees C, this is in conformity with industry practice which has never been able to provide the 2 degs C.
   ii. The NOTE has also been deleted
   iii. A new NOTE has been added that refers to dryers for surgical tool air requiring chemical drying (E.G. Desiccant).

NB Refrigeration driers were previously publicly advertised as being able to provide a pressure dew point of 2 degs C, the latest information from the manufacturers indicates that it is now in the vicinity of 3 to 4 Degs C. The variation in moisture content between 3 and 5 degs C is 164 ppm. 1084 ppm at 5 Bar and 1248 ppm at 7 Bar, the atmospheric pressure Dew Point of this air is minus 19 Degs C at 3 Degs C and minus 17.4 at 5 Degs C. The difference is considered an acceptable level that will not create any safety or mechanical issues.

d. 2.9.2.5 AIR INLET AND FILTRATION
   i. Considerable changes have been added in this Clause, previously a single final filter was an acceptable level. This revision now requires three levels of filtration, pre, final and activated carbon.

NB The activated carbon filter does not have a differential pressure gauge as the element adsorbs oil vapours and odours at the molecular level and does not generate a pressure loss within the element. It must be changed on a time relative regular basis calculated on the hours of use and the expected flow rate, usual practice is to base design on 12 months turnaround. The use of Activated Carbon is primarily for the removal of odours, there should not be any oil vapours in the medical air source of supply unless drawn into the compressed air intake.

e. 2.9.4 CONTROL SYSTEMS FOR PENDANTS AND COLUMNS
   i. This Clause replaces the earlier Clause *Medical breathing air supply to special care locations* which is now covered by Clause 2.4.10 EMERGENCY GAS SUPPLY

NB The Medical Air supply may now be used for the inflation of pneumatic brakes and pendant controls, it MUST be regulated and include flow controls to protect the supply source in the event of mechanical failure.

f. FIGURE 2.6 EXAMPLE OF LAYOUT FOR CENTRAL SUPPLY SYSTEM FOR OXYGEN WITH DUAL STATIONARY CRYOGENIC VESSELS.
   i. This is a new Figure to indicate a schematic layout for dual Oxygen vessels, the vessels may be situated side by side or remotely from each other. The actual installation will vary from site to site according to construction details and the health care facilities requirements.

NB The layout indicated here is becoming more common, the use of twin vessels either located side by side or on opposite sides of a site has become standard practice for most major hospitals.

g. FIGURE 2.7A EXAMPLE OF AN ESSENTIAL SUPPLY SYSTEM FOR MEDICAL AIR (DUPLEX COMPRESSOR SYSTEM)
   i. This figure replaces the earlier Figure 2.5, it shows greater details on the installation of the new filtration systems nominated in Clause .9.2.5 AIR INLET AND FILTRATION.
   ii. The location of the refrigeration driers is in the same format as the previous standard.

NB This is the standard configuration that has been used for many years, the change here is in the addition of a comprehensive filter set that will now remove odours, any entrained oil vapours drawn into the air intakes and provides protection for the final and activated carbon filters with the addition of a pre filter.

h. FIGURE 2.7B EXAMPLE OF AN ESSENTIAL SUPPLY SYSTEM FOR MEDICAL AIR (Triplex COMPRESSOR SYSTEM)
   i. This is a new figure providing details of a triplex installation.
   ii. The location of the refrigeration driers is in the same format as the previous standard
i. FIGURE 2.7C EXAMPLE OF AN ESSENTIAL SUPPLY SYSTEM FOR MEDICAL AIR (TRIPLEX COMPRESSOR SYSTEM)- ALTERNATIVE DRYING AND FILTERING ARRANGEMENT
   i. This is a new figure providing details of a triplex installation.

NB In this example the location of the refrigeration driers is installed prior to the Air Receiver, this is indicative of systems using integrated compressor/drier combinations. It is also acceptable to install stand alone driers prior to the air receivers, this assists in the prevention of rust within the air Receivers and will reduce internal corrosion and prolong the life span of the equipment

j. FIGURE 2.8 EXAMPLE OF A LAYOUT FOR CENTRAL SUPPLY SYSTEMS WITH GAS CYLINDERS
   i. The schematic replace the previous fig 2.6.

6) MEDICAL SUCTION SYSTEMS
   a. 2.10.1 PERFORMANCE
      i. This Clause now includes a reference to an additional Figure 2.9B, this figure shows the schematic layout of a suction system using VSD controls which remove the need of vacuum storage vessels.

NB This alternative allows the system to operate at a fixed pressure of minus 70 kPa (or as per the recommended pressure by the manufacturer, which provides better efficiency for the evacuation of the systems. E.g. at minus 90 kPa a 100 cubic metre per hour vacuum pump will operate for 10 hours to remove 100 cubic metres of free air, at minus 70 kPa the same pump will require 3 hours to do the same.

b. 2.10.2.3 c) Suction Receiver
   i. An additional NOTE has been added referring to the use of receivers when VSD controls are used.
c. 2.10.2.3 c) PUMP INLET FILTERS
   i. A new paragraph has been included here to include information on the biological filters.
d. .1 General
   i. An additional Clause 2.10.4 has been added which nominates the inclusion of a scavenge outlet at every location where inhaled anaesthesia is intended..

NB This is a new requirement, the use of Scavenge has become standard practice in clinical situations

7) 2.11 AIR FOR SURGICAL TOOLS
   a. This is a new Clause that provides details about the supply source for surgical air and the levels of dryness required. It has considerable ramification as it is now possible to supply this gas from an oil flooded compressor and using a desiccant drier. When read in conjunction with Clause 3.3.2 PIPELINE DESIGN PRESSURE AND FLOWS and FIGURE 3.2 PRESSURE/FLOW REQUIREMENTS OF TERMINAL UNITS that specify the design working pressure of 1,200 kPa (down from 1,400 kPa) this provides a considerably cheaper method of surgical air production (when taking operating costs into consideration).

NB The alteration of the operating pressure from1,400 kPa to 1,200 kPa provides the opportunity to install oil flooded screw compressors for this application. If compressors are used it is necessary to install a desiccant drier for moisture removal, when this is used it is necessary to add 20% of the design flow rate for the compressor capacity to allow for waste air used in the drying process to recycle the desiccant beds. The flow rate for Surgical Air has also increased from 250 l/min to 350 l/min.

   b. FIGURE 2.10 TYPICAL LAYOUT FOR CENTRAL SUPPLY SYSTEM FOR SURGICAL TOOL AIR
      i. This is a schematic diagram for the surgical tool air installation.
8) 2.12 LOCATIONS OF SOURCES OF GAS SUPPLY
   a. 2,12,1 CRYOGENIC LIQUID SYSTEMS
      i. A new NOTE has been added, this does not relate to the gases installation but refers to the access road for tankers or filling vehicles and would be a reference for the architects
   b. 2.12.2.2 SECURITY
      i. A NOTE has been deleted from the original document (2.22.2.2 Security)

NB It referred to the fact that medical gases are life support systems and security being extremely important

9) 2.13 ENCLOSURES FOR CYLINDER SUPPLY SYSTEMS
   a. 2.13.1 This Clause has been substantially rewritten, it references AS 4332 THE STOREAGE AND HANDLING OF GASES IN CYLINDERS. References to flammable gases such as ether and cyclopropane are no longer included.

NB Operating theatres no longer use flammable gases

   b. 2.13.2 INSTALLATION INSIDE A BUILDING
      i. Reference to NFPA 99 (US Medical Gas Installation Code) has been deleted.

ii. Reference to cylinder packs and doorway sizes has been added.

c. Original Clause 2.12.4 STORAGE OF CYLINDERS has been deleted.
   i. Reference to AS 4332 covers this Clause
d. 2.13.4 INTERIOR AND EXTERIOR ENCLOSURES
   i. Clause a) has been rewritten but basically says the same thing.
e. 2.13.5 SIGNS
   i. This Clause replace 2.12.6, the text remains unchanged
f. 2.13.6 DELIVERY ACCESS AND DOCKS
   i. This Clause replaces 2.12.7

10) <u>SECTION 3 GENERAL REQUIREMENTS</u>

a. 3.1 ALARMS
   i. 3.1.1 GENERAL
      1 The only alteration in Clauses a) to e) is the deletion of the NOTE at the end of sub Clause e)
      2 Additional NOTES have been changed as follows
         a. Sub Clause 3) the wording has changed from "In MOST anaesthetizing locations" to "In ALL anaesthetizing locations"
         b. The second paragraph in sub Clause 3) is now a separate paragraph 4)
         c. A new sub Clause 4) has been added and refers to protection of both Nitrous Oxide and Medical Air that may be necessary and references Clause 2.3.1
         d. Original Sub Clause 4) is now sub Clause 5)
         e. Original sub Clause 5) is now sub Clause 6).
         f. Original sub Clause 6 is now sub Clause 7)
         g. Original sub Clause 7 has been inserted into sub Clause 3)
         h. Sub Clause 8) remains

This clause now requires that a medical gas alarm panel is included in all Anaesthetizing location, this includes Maternity Units where any room that has Nitrous Oxide piped could be an Anaesthetizing location and must have an Alarm Panel

   ii. 3.1.2 INSTALLATION REQUIREMENTS
      1 (a), NOTES
         a. 2) An additional NOTE has been added that clarifies the requirements for Anaesthetic Bays
      2 (b) ii) Two notes (ii and iii) have been combined into one which has the same meaning
   iii. 3.1.3 INDICATOR PANELS
      1 Sub Clause (d) Note i) references the reset time for alarms depending on the location of the gas system
   iv. 3.1.4.4 LOCAL FAILURE ALARM
      1 An additional sentence has been added to the end of the second paragraph that clarifies that alarm switches are not necessary after any isolation valves that are situated at fixed secondary equipment such as pendants.

NB The Standard requires that alarm pressure switches must be installed after the last isolation valve in any pipeline except in multibed locations connected to common isolation valves. In locations where

isolation valves are also fitted to fixed secondary equipment (e.g. Pendants) it is not necessary to fit pressure switches downstream of these locations. Refer to clause 4:14:3 for details of pendants and booms

b. 3.2 MATERIALS
   i. 3.2.1 GENERAL
      1 A new NOTE has been added that conforms the acceptance of PVC for venturi exhaust pipelines.
   ii. 3.2.2 OXYGEN COMPATIBILITY OF COMPONENTS
      1 An additional NOTE 3 has been added that references ISO 15001 for guidance on oxygen compatibility
      2 3.2.3.1 GENERAL
         a. New NOTE 2 added, references components other than pipes may be cleaned to a surface contamination level of 220 mg/m^2

3.3 REQUIREMENTS FOR PIPELINES

c. 3.3.2 PIPELINE DESIGN PRESSURE AND FLOWS
   i. The previous Clause has been deleted in its entirety, the new Clause includes the following comments.

Specific note should be taken here that Clause 3.3.3 SURGICAL TOOL GAS has been deleted which refers to the makeup of and the preference for the use of cylinders to supply of it as well as the preference of AIR over NITROGEN for this purpose.

   ii. A new TABLE 3.1 has been included giving the working pressures for Medical Gas supplies at 415 kPa, Surgical Tool Air Supply at 1,200 kPa and Medical Suction at minus 60 kPa.
   iii. Maximum and minimum pressures are provided for all gases
   iv. Reference is made to Appendix B for design flow rates and also to discussion with the Health Care Facility to determine their requirements.

NB It is almost impossible to have discussions with the staff of new facilities to determine what their requirements will be as far as diversity of flows is concerned. The Standard is based on years of experience and may well over compensate however without guidelines to provide actual data on which to calculate these flows the Standard is considered best practice.

d. 3.3.3 IN-LINE FITTINGS AND VALVES
   i. A NOTE has been added that references the restrictions that can be caused by valves, mass flowmeters and similar devices
   ii. The sentence that refers to the installation of fittings in buried pipelines has been deleted.

11) 3.4 PIPELINE SHUTOFF VALVES
   a. 3.4.1 GENERAL
      i. The original Clause also references the use of slow opening valves which is obviously not practical, that has been deleted as has the reference to ball and butterfly valves on high pressure pipelines.
   b. 3.4.2.1 Valve Boxes- General
      i. Advice regarding the location of valve boxes has been relaxed but does suggest that preference should be given to accessibility for Fire Brigade Officers
   c. 3.4.2.1 Valve Boxes-Box windows

i. Adds a reference to Figure 3.1 depicting an isolation valve box, shows the three way valve and pressure switch inside the valve box.
ii. Adds two NOTES
    1 The first NOTE suggests that the inclusion of a NIST connection would be a good idea.
    2 The second NOTE recommends that a gauge and pressure switch inside the valve box would be advantageous

NB Valve boxes will now require the inclusion of a three way valve and pressure switch, the inclusion of a NIST connection is standard practice in the UK. This may become a standard inclusion at some future time.

d. 3.4.3 Positioning
    i. A new Clause that is somewhat out of position, it states that birthing suites shall have an alarm in each room and at least one zone isolation box in each suite.
    ii. An additional NOTE has been included suggesting that separate isolation valves MAY be used for each delivery room.
    iii. The Fig 3.1 has been moved into this Clause

12) 3.5 TERMINAL UNITS AND CONNECTIONS
a. 3.5.1 GENERAL
    i. The NOTE has been rewritten and no longer references vacuum regulators for patient use.
b. 3.5.2 FORM AND DIMENSIONS
    i. The Clause has been made more specific and uses references to AS2902-LOW PRESSURE HOSE ASSEMBLIES for the dimensions of medical gas terminal units. All references to Quick Connect connections have been deleted. Additional information has been included that uses NIST connections to ISO 5359 for gases other than those covered by AS 2902.

NB Quick Connection Medical Gas Terminal Units are not used in many locations, the usage is so small that Esco no longer manufacture them

c. 3.5.4 Performance
    i. Terminal units shall be certified by the manufacturer to comply with the performance requirements specified in FIGURE 3.2 and that the system tests will comply with the requirements of Clauses 5.5.3.1 and 5.5.3.2

NB This is a type test and is NOT possible as part of the installation test procedure

d. 3.5.5 SITING OF TERMINAL UN ITS
    i. This Clause combines previous Clause 3.5.5 and 3.5.6 (MULTIPLE TERMINAL UNITS)

NB Gives details of centre distances and spacing of terminal units

e. FIGURE 3.2 PRESSURE/FLOW REQUIREMENTS OF TERMINAL UNITS
    i. This FIGURE includes a schematic of test equipment to be used for testing terminal units, it is a bench test setup to be used by the manufacturer.

ii. There is a TABLE that provides expected flows and pressures that must be available from these outlets when tested on the bench test equipment noted above.
iii. There are additional settings given and alterations provided to suit current requirements of this standard,
1 Surgical Tool Air has been changed to a test pressure of 1,000 kPa and a flow rate of 350 l/minute
2 Suction/Scavenging has been added using the same pressure and flow as vacuum.

NB These tests cannot be performed in situ on site

f. FIGURE 3.3 SPACING BETWEEN TERMINAL UNITS
i. A new FIGURE has been included to give minimum dimensions between terminal units and fixed obstructions.

NB Gives details of centre distances and spacing of terminal units

g. 3.5.6 IDENTIFICATION
i. A second NOTE has been added referring to dual colour coding for backgrounds to be of equal prominence.
h. 3.5.7 DISCHARGE FOR VENTURI OPERATED SUCTION OUTLETS
i. Changes to this Clause include the addition of a reverse flow prevention device.

NB Venturi Suction terminal units are open to the exhaust port at ALL TIMES, if multiple exhausts are manifolded and the common exhaust occluded the exhaust from any other operating terminal would vent through the next nearest terminal unit.

i. 3.5.8 CONNECTION BETWEEN TERMINAL UNITS AND EQUIPMENT
i. NEW Clause to confirm that connections between terminal units and equipment shall be by the use of SIS (Sleeve Index System) devices and hoses to AS 2902

NB This would be the same for pendant internal hoses

13) 3.6 IDENTIFICATION OF PIPELINES
a. 3.6.1.2 WHERE INACCESIBLE OR IN AREAS OF RESTRICTED ACCESS
i. The Clause has been rewritten however most of it retains the same intent, a new NOTE has been added stating that this Standard does not require exposed pipelines to be painted.
ii. Colour coding has been referenced to Table 3.2 which has been updated
iii. References to AS2700 have been removed although it is used in TABLE 3.2
b. PRESSURE GAUGES
i. This Clause has been changed to indicate the colour bands that are now applicable to Surgical Tool Air.

NB The previous version included a TABLE 3.1 SLEEVE INDEX SYSTEM, this has been deleted as it is part of AS 2902

ii. TABLE 3.2
1 This table nominates the identification colours to be used for medical gas pipelines, it has been expanded from the previous version and now includes Oxygen/Helium mixtures

14) SECTION 4 INSTALLATION REQUIREMENTS

a. 4.1 GENERAL
   i. A new NOTE has been added that provides examples of areas that are not to be connected to medical gas pipelines, includes sterilizers, CSSD, laboratories, air conditioning, laundries and fire systems.
   ii. The NOTE has been expanded on the use of the "Permit to Work" form in the appendix and on the use of the Appendix F WORKMANSHIP
b. 4.2 ELECTRICAL SEGREGATION
   i. The reference to a 50mm barrier between gases and electrics deleted, it is covered in AS 3000.
c. 4.3.3.2 BURIED PIPELINES
   i. The NOTE has been expanded to include a reference to obtaining advice re the type of cathodic protection that is required

NB This will be dependent on local site conditions

d. 4.5 RISERS AND DROPPERS TO TERMINAL UNITS
   1 The NOTE has been deleted. (referred to the reasoning behind the decision to use these sizes)

NB The use of these sizes has added advantages apart from providing for future expansion, in particular the use of 20mm pipe for suction will effectively slow the velocity of any unintentionally entrained contaminants which will be slowed and not travel upstream for any great distance thus reducing the problems that would be encountered under normal circumstances.

e. 4.11 PIPELINE SUPPORTS
   i. The Clause references the use of metal construction (previously nominated as "suitable material")
f. TABLE 4.1 MAXIMUM SPACING FOR BRACKETS AND CLIPS
   i. The table has been updated to match the same table from AS 4809 Copper Pipe and Fittings, TABLE 6.2.
g. 4.13 CONNECTION TO AN EXISTING SYSTEM
   i. 4.13.1 GENERAL
      1 The reference to Figures 4.1 and 4.2 have been deleted,

NB These FIGURES have also been removed from the Standard

   ii. 4.13.2 INSTALLATION OF AN ADDITIONAL PIPELINE
      1 New paragraph added, this references the method of securing any isolation valve in a new pipeline if there is no downstream pressure monitoring, i.e. The valve shall be permanently disabled in the OPEN position.
h. 4.14 FIXED SECONDARY EQUIPMENT (e.g. Pendants, Ducts etc)
   i. 4.14.2.3 GAS SERVICES
      1 Paragraph 3 has had the BS 5682 reference altered to ISO 5359 for the NIST connection.
      2 The Clause also clarifies the type of fitting to be used for this purpose i.e. cannot be removed without destroying the fitting.

NB These fittings are usually provided as part of a Pendant or similar, it is not likely to be supplied as part of a medical gas pipeline independently.

A new NOTE has been added that references the use of compatible hoses specifically for N2O and CO2.

NB These gases are absorbed into some synthetic materials such as Viton, they will also extract the plasticizers from some flexible tubes which will cause them to become brittle and fail.

3 The NOTES from the previous revision have been combined into a single group.
4 The nominated NIST connection for Surgical Tool Air is now A-6 in ISO 5359

i. 4.14.3 SPECIFIC REQUIREMENTS OF PENDANTS AND BOOMS

1 A new paragraph has been added that requires the installation of isolation valves adjacent to any single patient location where multiple locations are controlled from a single isolation valve box.
2 A new NOTE has been added that clarifies that an Induction Room and Operating Theatre are considered as one location, this deletes the requirement for the provision of isolation valves in this instance. Multi patient locations would still require independent isolation valves.
3 The second NOTE in the previous document referring to rotary gas seals and rotary electrical wipers has been deleted (this was impractical)
4 A new paragraph has been added that nominates that any non moving part of a pendant or boom shall have a minimum clearance of 1.9 metres
5 A new paragraph has been added that refers to pendants or booms that have a base higher than 1.5 metres in ANY position should be designed with smooth blunt surfaces.

NB The new work will require the installation of isolation valves in areas where multiple bed locations are installed each having services mounted in Pendants when they are all served from a common source. There was some confusion regarding the installation of an alarm panel in an induction room AND the Theatre as both were considered as Anaesthetizing locations, this has been clarified now as a single area.
In the previous version FIGURE 4.1 and 4.2 TYPICAL ARRANGEMENTS In the previous version have been deleted.

15) SECTION 5 TESTING AND COMMISSIOING

i. 5.1 GENERAL

1 An additional sub Clause (m) has been added, this requires that the Medical Air Supply has been tested for compliance with AS 2568 (Purity of Medical Breathing Air)

NB This will now be required during the commissioning of the project

ii. 5.2 TESTING, VERIFICATION AND CERTIFICATION

1 Two paragraphs have been added that nominate calibration times for test equipment and accuracy levels.

NB Test equipment used for commissioning now requires proof of accuracy. It has been common practice in the past that pressure gauge test sheets were not provided as the test gauges were compared to "in house" test gauges. This is not possible as test sheets do not prove that a test gauge is accurate they only give details about the accuracy of the reading of the tested gauge. E.G. if a tested gauge was 10% off the gauge is NOT corrected, the test certificate for that gauge would indicate the

error, any gauges compared to that gauge would then require an additional test sheet to indicate how it compared to the test gauge..

b. 5.4 TESTS AND CHECKS ON PIPELINE BEFORE CONCEALMENT
    1 5.4.1 GENERAL
        a. A new NOTE has been added referring to the purging of CO2 from pipelines and the dangers associated with the accumulation of CO2 buildup.

NB This is particularly related to the removal of any CO2 prior to purging with the final gas supply, at this stage of construction it could be in a closed room or area without any operating ventilation during the purge process.

ii. 5.4.3 INITIAL PRESSURE TEST
    1 Sub Clause (b) has been altered to take the new operating pressure of Surgical Tool Air into consideration.

iii. 5.4.5 PARTICULATE MATTER TEST
    1 <u>This Clause has been substantially altered to include a suitable test for particulate matter. Flow rates have been confirmed and the pore size of filtration papers set at 5 mu</u>

NB The Particulate Matter Test has been rarely done in the past, it is becoming a matter of concern as the number of experienced installers in the field is limited and oxidation of welded joints could become more common as the volume of work increases.

iv 5.4.6 TESTS FOR CROSS CONNECTIONS
    2 5.4.6.2 IN a PIPING SYSTEM WHICH IS AN ADDITION TO AN EXISTING SYSTEM
        a. The NOTE has been rewritten to clarify the use of the Permit to Work form and its location

c. 5.5 TESTS AND COMMISSIONING OF THE COMPLETE PIPELINE SYSTEM
    i. 5.5.2 PRESSURE TEST
        a. <u>The NOTE has a sentence deleted that previously confirmed that an overall test was still required even after testing of individual zones.</u>

NB This may not be possible, in large installations standard practice dictates that areas are progressively handed over to the Health Care Facility well in advance of final completion and system testing is not possible when areas are actively in use.

d. 5.5.3 TESTS FOR FLOW RATE AND PRESSURE
    i. 5.5.3.1 INSTALLED TERMINAL UNIT FLOW TEST
        a. An additional paragraph has been added clarifying that each suction terminal unit shall have a flow rate of 40 l/min and have a static pressure of minus 60 kPa
    ii. FIGURE 5.1 TEST DEVICE was 5.3

NB This is for pipeline testing, similar tests are used for bench testing of terminal units that use different pressures (i.e. 55 kPa)

e. 5.5.3.2 PIPELINE DISTRIBUTION SYSTEM FLOW TEST

i. Sub Clause (a) has been changed to nominate Clause 3.3.2 as the required ranges for the results.
ii. A new NOTE has been added, this refers to the method of calculation of pipeline design flow rates.

NB The formula that has been suggested is currently the most commonly recognized for calculating flows of compressible fluids and software can be purchased for this purpose.

iii. The NOTE clarifies that on large systems it is acceptable to provide calculations to prove flow rates and pipe sizes are correct as it would not be possible to carry out the actual flow test as the flow would exceed the capacity of the plant. This needs to be taken into consideration on additions to existing systems that are in operation to prevent drawing excess gas from a pipeline and thereby causing a system failure. Records of calculations must be provided and kept.

NB The use of computer software for calculating pipeline sizes is becoming more prevalent. Proof of calculations will need to be kept for future proof if necessary and as a guide for future extensions should they be required.

iv. New NOTES have been added at the end of this Clause,
v. Flow tests for Suction should be conducted over a complete cycle of the vacuum plant.

NB There will be a considerable variation in pressure drop depending on the pipeline pressure that is applicable at the time of the test

vi. Flow calculations for venturi systems should be carried out simultaneously with the medical air.

NB This calculation adds the flow requirements of the Venturi Suction terminal units to that of the Medical Air to provide an accurate plant size calculation.

f. TABLE 5.1 PIPELINE DIFFERENTIAL PRESSURE REQUIREMENTS AT TERMINAL UNITS
    1 Pressure and flow rates have been changed and Suction has been deleted, a NOTE 4 has been added to clarify the Suction requirements.
    2 Compressed Air for driving Surgical Tools has changed to 1,200 kPa, the flow rate is now 350 l/min, the max differential pressure is now 80 kPa and the max pipeline differential pressure is now 120 kPa.
    3 The pressure drop or the pipeline on gases used for driving ventilators is now 80 kPa.
    4 Note 4 has been deleted from the original and replaced with a reference to Clause 5.5.3.1.

NB The Surgical Tool Air flow rate calculation needs to take any demands from the Desiccant drier into consideration, they use approximately 20% of the FAD of the design flow of the drier, an oversized drier will still use 20% of its design flow rate even if it is operating on a smaller capacity plant

g. 5.6.5 TEST FOR GAS IDENTITY (previously concentration)
    i. 5.6.5.2 TESTS FOR GAS IDENTITY
        1 The list of gases has been extended to include CO2

2 The acceptance ranges of the gases being tested has been widened.
   a. Oxygen is now 95%
   b. Medical Air is now 20 to 22%
   c. Surgical Tool Air is now 20 to 22%
   d. Nitrous Oxide is now less than 5%
   e. Carbon Dioxide is less than or equal to 5%

The reduction in acceptable test levels in particular for Oxygen should not reduce the likelihood of a cross connection as long as the requisite test procedures have been completed in accordance with this Standard. It is imperative that a comprehensive testing regime is carried out to ensure the complete safety of the system for patient use. FAILURE to do this may allow the system to pass into use which will put patient's lives at risk.
It is suggested that a WORK METHOD STATEMENT be produced that shows the methodology to be followed to ensure the steps to be taken will prevent any errors or cross connections in the system. This is of particular importance with large installations where handover of zones or areas will occur prior to final handover.

ii. 5.6.5.4 FAILURES DURING IDENTITY TESTS
   1 The system recommissioning level has been reset from 20% to 10%.
   2 A previous NOTE referring to cleaning solvents has been deleted.

NB The failure rate of 10% requires that the complete system must be retested, below that only the local area is retested.

iii. 5.7.3 HANDOVER INSTRUCTIONS
   1 This is a new Clause, it clarifies the procedure to be followed with Test Certificates on completion

NB This clause clarifies the procedure for handover, the Test Certificate or Certificates are to be handed over to the Health Care Facility along with the Operating Manual on handover.

iv. 5.7.5 CERTIFICATE OF COMPLIANCE
   a. This is a new Clause, it clarifies what details are required on a certificate of compliance.

NB The Certificate of compliance shall include the Date of test, Name of testing personal, Appropriate Standard (AS 2896) and the Scope of Compliance. Any non complying areas or failures must be noted on this Certificate.

16) <u>SECTION 6 MAINTENANCE</u>

a. GENERAL
   i. Paragraph two has been reworded to clarify who is suitably qualified to carry out maintenance of medical gas pipelines. The responsibility for ensuring this is with the Health Care Facility.
   ii. Clarification of record keeping and what records are to be kept.
   iii. Responsibility for record keeping is the responsibility of the Health Care Facility
   iv. 6.3.3 CHECKING MANIFOLDS
      1 A new clarification that refers to excessive frosting on manifolds may require discussions with the manufacturer.
b. 6.5 MAINTENANCE OF TERMINAL UNITS

i. There are two NOTES that have been deleted, the first refers to the likely damage to terminal units through use and the other to pre 1986 terminal units, both have been deleted.

NB It is a requirement of this clause that Terminal Units are inspected at least every two years, it would be standard practice that this would be outside the period of Guarantee from the installer and therefore becomes the responsibility of the Health Care Facility.

c. 6.8 LOW PRESSURE FLEXIBLE HOSE ASSEMBLIES
   i. This is a new Clause that recommends the visual inspection of these hoses and pressure testing at no less than one year intervals.

NB It is the responsibility of the Health Care Facility to provide ongoing service and maintenance inspections, under normal conditions these hoses are not provided by the installation company.

17) APPENDIX A LIST OF REFERENCED DOCUMENTS

a. New references include
   i. AS 2473 Valves for compressed Gas Cylinders (prev numbered as 2472)
   ii. AS 2473.3 Part 3 Outlet connections for medical gas cylinders
   iii. AS 4706 Pressure Gauges for regulators for compressed gas cylinders
   iv. AS 4809 Copper pipe and fittings Installation and commissioning
   v. AS 1167 Welding and Brazing. Filler metals
   vi. AS 1167.1 Filler metal for brazing and braze welding
   vii. AS 2865 Safe Working in confined spaces
   viii. ISO 5359 Low Pressure Hose Assemblies for medical gases
   ix. ISO 8573 Compressed Air
   x. ISO 8573-1 Part 1 Contaminants and purity classes
   xi. ISO 10524 Pressure Regulators for use with Medical Gases
   xii. ISO 15001 Anaesthetic and Respiratory Equipment-Oxygen compatibility
   xiii. ISO 21969 High Pressure flexible connections for use with Medical Gas Systems
   xiv. National Transport Commission
   xv. Australian Dangerous Good Regulations

NB The above are NEW additions to this list only

18) APPENDIX B GUIDE TO PERFORMANCE OF TYPICAL MEDICAL GAS PIPING SYSTEMS o

a. B2 GENERAL
   i. Paragraph five has had the design flow rate for surgical tool air changed to 350 litres/min
   ii. There is a sentence that Recovery Wards should have a single Medical Air and Nitrous Oxide Terminal unit fitted. This is not required in Day Procedures Units.
b. TABLE B1 GUIDELINE FOR TERMINAL UNITS, DESIGN FLOW AND PLANT CAPACITY - OXYGEN
   i. Only one alteration has been made and that is for Dental Oxygen, the use flow rate for "Other" units has been included.
c. TABLE B2 GUIDELINE FOR TERMINAL UNITS, DESIGN FLOW AND PLANT CAPACITY –MEDICAL AIR
   i. There has been a change in the design flow rate for the Medical Air pipelines for Operating Theatres, Anaesthetic Rooms, and Recovery Rooms, these have been decreased to 20 from 40 litres per minute per minute per terminal unit.

ii. The flow rate for an Intensive Care Bed pipeline has been reduced from 125 to 100 litres per minute per terminal unit.
iii. The NOTE 2 has been rewritten and the alterations to the adjusted flow rate for Medical Air for driving ventilators has been deleted.
iv. There is a reference in Clause B2 that notes that the single Medical Air terminal unit is not required in a Day Procedures unit

d. TABLE B3 GUIDELINE FOR TERMINAL UNITS, DESIGN FLOW AND PLANT CAPACITY –NITROUS OXIDE
   i. There are no alterations to this page however there is a reference in Appendix B,Clause B2 that notes that the single Nitrous Oxide terminal unit may be required in a recovery ward however this is not required in a Day Procedures unit
e. TABLE B4 GUIDELINE FOR TERMINAL UNITS, DESIGN FLOW AND PLANT CAPACITY –MEDICAL SUCTION
   i. There are no alterations to this page however there is a reference in the documents that requires an allowance for Scavenging Terminal Units to be fitted in all Anaesthetizing Locations. The areas affected include Operating Theatres, Anaesthetic Bays, Recovery Wards (I off), Maternity Units and Accident & Emergency Units, this additional demand must be included in plant design flow calculations..

NB This revision now clarifies the installation of Scavenge terminal units at all Anaesthetizing locations, it is now necessary to add the recommended flows to the calculation of the design flow rate for Suction.

19) APPENDIX C OPERATING ALARM SYSTEMS

a. Situation
   i. Normal Operating System
   ii. There are alterations to the pressure settings for Suction and Surgical Tool Gas Alarms in the Remarks Column,
   iii. Settings for Suction have been adjusted to minus 48 kPa as the set point for the Supply Normal
   iv. Settings for Surgical Tool Air have been adjusted to 960 kPa as the set point for a the Supply Normal
   v. The Sensor Location has been changed to read "Between the terminal units and the last isolation valve.
b. Failure of System
   i. Sensor location has been altered to read "Between the terminal units and the isolation valve, the previous reference included a reference to other areas "downstream of the line pressure regulator and the main isolation valve.
   ii. Switching condition has been changed to 330 kPa (previously 320 kPa) and the working pressure is now 415 kPa from 400 kPa previously.
   iii. A NOTE has been added that clarifies the location of "failure of supply" sensors.

20) APPENDIX E OUTLINE FOR DETERMINING COMPETENCE OF INSTALLER.

a. A new NOTE has been added that comments on the Health Care Facilities option to seek additional information.

21) APPENDIX F GUIDANCE TO QUALITY OF WORKMANSHIP IN CONSTRUCTION

a. The previous clause F3 Valve Identification board has been deleted.

22) APPENDIX G FLUXLESS BRAZING TECHNIQUE

a. Clause G2 GENERAL has been expanded to include details on working with CO2 in confined and non ventilated areas, references are provided to AS 5034 and AS/NZ 2865 and to State OHS regulations.
b. Clause G5 has been clarified and some parts deleted, references to clinical indicators have been removed.
c. Clause G6 has been defined and reference to expected site conditions have been deleted.
d. Clause G7 has had a reference to AS/NZ 2865 included.
    i. Sub clause (e) has been rewritten recommending a Risk Assessment be performed and continuous testing for CO2 concentration be carried out.
e. Clause G13 has been deleted in its entirety, the committee are of the opinion that the use of 45% silver solder is no longer necessary and due to the level of cadmium that this solder contains it was not a preferred substance for use for safety reasons.
f. FIGURE H1 LOGISTIC DIAGRAM FOR TESTING OF PIPELINE SYSTEM
    i. Test pressures nominated in the diagram have been updated to suit new operating pressures for Surgical Tool Air
g. FIGURE H2 TEST CERTIFICATE FORM (T1)
    i. Surgical Tool Air pressures have been adjusted to suit new pressure settings.
    ii. Cross Connection tests have been altered to include negative pressure setting for suction systems (previously 140 kPa positive)
h. FIGURE H9 NON CONFORMANCE REPORT FORM
    i. Basic changes to descriptive text, Proposed resolution Section added.
    ii.

23) APPENDIX I TERMINAL UNIT TEST FORM

a. Layout alterations.

24) APPENDIX L CONVERSION FACTORS FOR UNITS USED IN THE MEASUREMENT OF PRESSURE

a. NOTES deleted. (Conversion of specific kPa pressures to mm Hg)

GENERAL COMMENTS

1) TS11 and medical gases, there is a specific reference to the provision of Medical Air terminal units, AS 2896 does not call for a great deal of medical air terminal units in general wards unless there is a specific requirement (e.g. wards specifically used for breathing difficulties particularly with children.
2) The use of Venturi over Vacuum will add approx 30% to the project cost and future maintenance expenditure