PROVINCE OF KWAZULU-NATAL

DEPARTMENT OF HEALTH

STANDARD SPECIFICATION AND DRAWINGS

FOR

MEDICAL GAS AND VACUUM SERVICES

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THIS SPECIFICATION CONSISTS OF PAGES AND STANDARD DRAWINGS

THE CONTRACTOR/TENDERER MUST CHECK THE SPECIFICATION FOR ANY MISSING, DUPLICATED OR INDISTINCT PAGES AS NO CLAIMS WILL BE ENTERTAINED AFTERWARDS DUE TO WANT OF KNOWLEDGE OF THE CONTENTS OF THIS SPECIFICATION OR STANDARD DRAWINGS.

STANDARD SPECIFICATION

FOR

MEDICAL GAS AND VACUUM INSTALLATIONS

1. INTRODUCTION

1.1 General

This specification contains standard technical requirements for medical gas and vacuum installations and anesthetic mask scavenging systems.

1.2 Project Specification

This standard specification and drawings will at times have to be read in conjunction with project specification and drawings in which the specific requirements, scope and layout of the installation are set out.

Where contradictions arise between such project specifications and drawings and this standard specification and standard drawings, the project drawings and project specification will take precedence.

1.3 Queries

Where queries or disputes in interpretation of this specification and standard drawings vis-à-vis project specifications and drawings arise, the matter must be referred to the Secretary for Health or his duly appointed representative, whose decision will be final and binding.

1.4 Competence of Installation Technicians

It is a requirement that all pipe fitters employed in medical gas and vacuum installations are able to show proof of knowledge of, and experience in such installations before commencing work on a medical gas and vacuum system.

1.5 Permit to Work

Prior to any person working on or isolating any medical gas system, a Permit to Work, as described below, and as per form B15, will be required.

1.5.1 General

The Permit to Work system is applicable to the servicing, repair, alteration and extension of existing installations within a Hospital, or any action, such as the closure of an isolating valve, which restricts the supply. This means that Permits shall also be obtained before any major item of central plant, e.g. manifold, control panel, compressor, or vacuum pump (including and standby plant), is isolated prior to servicing, repair or overhaul. The system is applicable to work on installations already in service.

1.5.2 Routine Changing of Cylinders

Permits are not necessary for the routine replacement of cylinders on manifolds nor for the recharging of liquid oxygen vessels, provided there is no danger of the supply being disrupted when these tasks are undertaken.

1.5.3 Planned Preventive Maintenance (PPM) Work

Permits will not be required for routine daily or weekly inspections (where the service is not interrupted), but follow-up work will usually involve the issue of a Permit.

1.5.4 Substantial Alterations, Extensions to, or Overhaul of Existing Installations

Work described on the Permit should normally be completed in one day, though provision is made for some carryover. Work likely to take more than one day may be initiated on the Permit, but should be carried out under normal procedures for engineering work of this nature and commissioned in accordance with the requirements of part 2 of this specification.

1.5.5 Capital Works

Capital works undertaken by the Province's Works Department and other similar new work should be connected to an existing system only after a break point has been established. The new capital work should be tested and commissioned in the normal manner as provided for in part 2 of this specification.

1.6 Standard Drawings

The standard drawings listed here form part of this specification and must be read in conjunction with it: -

M040101 Key to Symbols
M040102 Typical Operating Theatre Layout
M040103 Typical Layout of Medical Gas and Vacuum Outlet Points at Bed Head
M040104 Vacuum Pipe Take-off Details
M040201 Diagrammatic Layout – Medical Compressed Air Piping and Equipment
M040202 Typical Oxygen and Gas Bank Layout
M040203 Diagrammatic Layout of Vacuum Plant Pipe Work and Equipment
M040204 Typical Nitrous Oxide Gas Bank Arrangement
M040301 Medical Gas and Vacuum Isolating Valve Cabinet
M040302 Theatre Pendant Details
M040303 High Pressure Compressed Air Outlets
M040305 Anesthetic Scavenging System for Operating Theatres
M040401 Concrete Base for Air Compressors and Vacuum Pumps
M040403 Gas Evaporator Enclosure Details
M040404 Details of Gas Cylinder Connections
M040501 Wiring Diagram for Vacuum and Compressed Air Plants
M040502 Typical Wiring Diagram for Medical Gas and Vacuum Warning Light Panels
M040503 Typical Warning Light Panel Layout
M040504 Alternate Compressor and Vacuum Plant Wiring Detail
M040505 Wiring Diagram for Anesthetic Mask Exhaust Fan

1.7 Other Standards and Publications

The following publications must be read in conjunction with this specification: -

1.7.1 Occupation Health and Safety Act (Act No. 85 of 1994) As amended.

1.7.2 Standard Specification for Electrical Installations Pertaining to Mechanical Equipment.

1.7.3 SABS 099 – 1974 The construction of air receivers.

1.7.4 SABS 460 – 1975 Copper and copper alloy tubing.

1.7.5	SABS	763 – 1977	Hot-dip (galvanised) zinc coatings.
1.7.6	SABS	948 – 1978	Three phase induction motors part 1 low voltage standard motors.
1.7.7	SABS	1091 – 1975	National colour standard for paint.
1.7.8	SABS	1189 – 1978	Single phase induction motors.
1.7.9	SABS	1062 – 1985	Vacuum and pressure gauges.
1.7.10	SABS	1409 – 1986	Outlet sockets and probes for medical services used in hospitals.
1.7.11	SABS	0224	Non flammable medical gas pipeline systems.
1.7.12	SABS	0142	Wiring of Premises
1.7.13	CKS	64 – 1967	Compressed Air for breathing.
1.7.14	CKS	332 – 1977	Industrial V-belts.
1.7.15	CKS	605 – 1987	Medical gas regulators.
1.7.16	R158	Regulation	Hospital norms.

2. PROCEDURE FOR VALIDATION AND VERIFICATION OF MEDICAL GAS PIPELINE SYSTEMS

2.1 GENERAL

The following tests, as applicable, are required for any additional/modifications to piping.

Tests are not required after servicing of or repairs to outlet points.

2.1.1 Important Notes - The system being tested may not be commissioned until all tests as specified have been satisfactorily completed.

2.1.2 The pre commissioning tests (i.e. Nº's 1 – 20) are to be executed/witnessed by: -

a) the contractors authorised representative

b) the responsible competent person

c) the project manager (if applicable)

d) the consultant (if applicable)

2.1.3 The identity tests (i.e. Nºs 20 – 21) are to be executed/witnessed by the persons as listed in 2.1.2 above, plus: -

e) The responsible clinical technician

f) Anesthetist/medical officer

2.1.4 It is incumbent upon the contractor executing the works to submit a written request for testing/commissioning to the project manager or competent person, at least 14 days prior to the proposed date. The project manager/competent person will then advise of all parties in writing of the confirmed date(s).

2.1.5 The contractor is to provide all necessary pressure testing equipment and gas. The Department of Health (CMTD) will provide the gas analyser.

2.1.6 The sequence of tests in this procedure is important and should be followed.

2.1.7 All tests will need to be planned and carried out by the appropriate persons. Forward planning will be necessary to ensure that the necessary persons and test equipment will be available.

2.1.8 Summaries of the tests required on the pipeline carcass and on the total pipeline system are given in Tables 1 and 2.

TABLE 1 SUMMARY OF TESTS REQUIRED ON PIPELINE CARCASS

Test Order	Description	Specification Clause	Form
1	Labelling and marking	2.2.1	B1
2	Sleeving and supports	2.2.2	B1
3	Leakage	2.2.3	B1
4	Cross-connection	2.2.4	B2

TABLE 2 SUMMARY OF TESTS REQUIRED ON PIPELINE SYSTEM

Test Order	Description	Specification Clause	Form
5	Leakage from total compressed system	2.3.1	B3
6	Leakage into total vacuum system	2.3.2	B4
7	Closure of Isolating Valves	2.3.3	B5
8	Zoning of Isolating Valves	2.3.3	B5
9	Cross-connection	2.3.4	B6
10	Flow and pressure drop at terminal units	2.3.5	B7
11	Mechanical function of terminal units	2.3.5	B7
12	Gas specificity of terminal units	2.3.5	B7
13	NIST connectors (Probes)	2.3.5	B7
14	Performance tests of the pipeline system	2.3.6	B8
15	Functional tests of supply system	2.3.7	B9
16	Pressure safety valves	2.3.8	B10
17	Warning systems	2.3.9	B11
18	Verification of drawings	2.3.10	B12
19	Filling with medical air	2.3.11	B14
20	Purging and filing with specific gases	2.3.12	B13
21	Gas identity	2.2.13	B14

2.2 TESTS ON THE PIPELINE CARCASS

2.2.1 Labelling and Marking

- Inspect each pipeline carcass to ensure that the pipelines are labelled in accordance with clause 12 and that the isolating valves are worked in accordance with clause 7 and that the terminal unit base blocks are marked in accordance with clause 6.4.

- If the labelling and marking I correct, complete Form B1.

2.2.2 Sleeving and Supports

- Inspect each pipeline carcass to ensure that the pipelines are sleeved and supported in accordance with the contract specification.

- If the sleeving and supports are correct, complete Form B1.

2.2.3 Leakage

- If it has been necessary to link the carcasses to form a single system for the purpose of this test, then care must be taken to ensure the links are removed. Alternatively, the test may be carried out on sections of the pipeline, provided no part of the pipeline is omitted.

2.2.3.1 General Conditions

- The pipeline should be completely installed and correctly supported. The base blocks of all terminal units should be fitted and blanked. Other devices such as safety valves or pressure sensors need not be fitted. All connection sockets for such devices should be blanked.

2.2.3.2 Procedure

- Connect a suitable pressure-measuring device to the pipeline. Fill the pipeline with test gas at the specified test pressure. Disconnect and remove the gas supply. Record the pipeline and room temperature initially and again at the end of the test period (24 hours).

2.2.3.3 Results

- The rate of pressure drop during the test should be less than 0.025% per hour, except for pressure changes due to temperature variations. The pressure change due to temperature variation is approximately 0.35% per ºC. Record the results on Form B1.

2.2.4 Cross Connection

- Any links between the systems should be removed before this test is carried out. All pipelines should be at atmospheric pressure and all isolating valves should be open. A single pressure source should be used and connected to one pipeline at a time. This should remain under pressure throughout the test. At least one base block on all other pipelines should be fully open.

2.2.4.1 Procedure

- Connect one pipeline to the pressure source. Check that no gas flows from the open base block on the other pipelines, which are not under pressure. Each terminal unit on the pipeline under test should be opened, checked for flow and then reblanked. When testing has been completed on one pipeline, the pressure source should be removed and that pipeline should be left open to atmosphere. Another pipeline should then be pressurised and the procedure repeated.

2.2.4.2 Results

- The contractor should record that satisfactory tests have been completed on Form B2.

2.3 TESTS ON THE PIPELINE SYSTEM

2.3.1 Leakage from Compressed Medical Gas Systems

- The leakage test described above should have been completed satisfactorily. All terminal unit valves and other devices such as safety valves and pressure sensors should be fitted. The supply system should be isolated from the pipeline. There should be no links between the pipeline systems. The test may be carried out on sections of each pipeline, provided no section is omitted. Different sections and pipelines may be tested at the same time.

2.3.1.1 Procedure

- Connect a suitable pressure-measuring device to the pipeline. Fill the pipeline (or section of pipeline) with test gas at pipeline distribution pressure. This filling procedure may also be used to measure the volume of the pipeline. Disconnect and remove the gas supply. Note the pressure and temperature initially and again at the end of the test period.

2.3.1.2 Results

- The rate of pressure drop during the test period should not exceed the value specified by the formula given in paragraph 2.2.3, after allowing for pressure changes due to temperature variation. Record the results on Form B3.

2.3.2 Leakage into Vacuum Systems

- The leakage test described above should have been completed satisfactorily. All terminal unit valves and other devices such as pressure sensors should be fitted. The vacuum supply should be connected to the system under test.

2.3.2.1 Procedure

- Connect a vacuum gauge to the system. Run the vacuum supply system to maintain pipeline distribution pressure until the pipeline system is dried out. With the system at pipeline distribution pressure, isolate the vacuum supply system. Note the vacuum initially and again after one hour.

2.3.2.2 Results

- Record the results on Form B4. The pressure increase after one hour should not exceed 10 kPa. There is no additional allowance for temperature variation in this test.

2.3.3 Closure and Zoning of Area Valve Service Units

- The test specified in paragraphs 2.2.1 – 2.3.2 must have been completed satisfactorily.

2.3.3.1 Procedure

The procedure for this test is as follows: -

a) connect a pressure-measuring device to the system. The system should be at pipeline distribution pressure, with all Area Valve Service Units (AVSU's) closed;

b) depressurise the pipeline downstream of the most remote valve from the source to 1 bar (g) pressure by opening a terminal unit valve. Close the terminal unit valve;

c) note the total number of terminal units controlled by the AVSU and check that these terminal units are correctly labelled and that they are all at the test pressure;

d) if necessary, re-adjust the test pressure to 1 bar (g). Read the pressure in the section under test and then read the pressure again after 15 minutes;

e) check the AVSU for leakage to the environment in both the closed and open positions.

2.3.3.2 Results

- Record the results on Form B5. There should be no pressure increase downstream of the valve under test.

- On each pipeline system, open the area valve service units in sequence towards the supply system repeating the above procedure.

2.3.4 Cross Connection

- These tests should be carried out on one pipeline at a time. All pipelines should be at atmospheric pressure and AVSUs should be open. A single pressure source should be used and connected to one pipeline at a time, which should remain under pressure throughout the test.

2.3.4.1 Procedure

The procedure is as follows: -

a) connect one pipeline to the pressure source at pipeline distribution pressure;

b) in order to depressurise the other system, insert an open probe into one terminal unit on each other system. Check that no gas flows from these probes (into or out of);

c) check that gas flows through every terminal unit of the pipeline under pressure;

d) check that there is no gas flow from any other terminal units when they are opened with the correct probes.

2.3.4.2 Results

- Record the results on Form B6 if there are no cross connections.

- Repeat the procedure described above on each pipeline in turn, including vacuum, preferably at one session. This test should be repeated in full if any subsequent modifications are made to the pipeline system during construction.

2.3.5 Functional Tests of Terminal Units

- These tests may be carried out at the same time as the cross connection test described above. In this case, only one system at a time is pressurised.

2.3.5.1 Procedure

The procedure is as follows: -

a) before commencing the tests, check that the test equipment meets the requirements given in Appendix C for the system under test. All terminal units should be complete with the fascia plate;

b) insert the test device described in Appendix C into each terminal unit in turn on the system under test. Note that the pressure drop at the specified flow does not exceed the value given in paragraph 2.2.3.3;

c) check that the gas specific probe can be inserted, captured and released and that it does not swivel in horizontally mounted terminal units;

d) check that no gas is released at each terminal unit by the probes for all other gases used and that no probes can be engaged;

e) check that all NIST connectors (probes) accept the NIST probe for the correct gas and that mechanical connection is made. Check that the NIST probes for all other gases do not make mechanical connection;

f) note that the NIST self sealing device functions correctly;

g) NISTs incorporated in certified assemblies do not need to be tested.

2.3.5.2 Results

- Record the results on Form B7.

2.3.6 Performance Tests of the Pipeline System

- These tests should be carried out on one system at a time.
- All AVSUs should be open. Connect a supply of test gas at the supply source of sufficient capacity to meet the total design flow of the system. The vacuum supply system may be used to test the vacuum pipeline system.

2.3.6.1 Procedure

The procedure is as follows: -

a) insert leaks into selected terminal units, AVSUs and NISTs as appropriate, throughout the system under test to provide a total flow equal to the total design flow of that system;

b) run the system so that the pressure/vacuum at the source meets the specification;

c) check the gauge pressure at the specified flow at selected terminal units throughout the system.

d) record the results on Form B8 if they are in accordance with the specifications;

e) remedial work may be needed if these specifications are not met.

2.3.7 Supply System Tests

2.3.7.1 General

- All supply systems should be installed and connected to normal and standby power supplies.

2.3.7.2 Procedure

The procedure is as follows: -

a) the functions and operating parameters of each item of plant should be checked;

b) the supply systems should be shown to operate on the essential power supply;

c) all pipe work joints should be tested for leakage at normal operating pressure;

d) the compressor plant should be tested for leaks during normal running. Minor leaks detectable as bubbles are acceptable.

2.3.7.3 Results

- It should be confirmed that the manufacturer's specification meets the requirements of the contract specification.
- Record the results on Form B9, if they are in accordance with the specific checklist.

2.3.8 Safety Valve Inspection

- Tests of safety valves are not required.

2.3.8.1 Procedure

The procedure is as follows: -

a) inspect each safety valve to check that the discharge capacity and the set pressure are in accordance with the contract specification;

b) check that the safety valves conform to BS6759: Part 2;

c) inspect the certification supplied with each valve.

2.3.8.2 Results

- Record the results on Form B10.

2.3.9 Warning System Tests

2.3.9.1 General

- The tests should be carried out for one function at a time on one system at a time.
- All alarm systems should be fully installed and in operation.

2.3.9.2 Procedure

The procedure is as follows: -

a) adjust the pressure in each pipeline system either locally or throughout the pipeline system;

b) observe that the appropriate changes in warning system conditions occur;

c) check that the warning system will operate from the essential power source.

2.3.9.3 Results

- Record the results on Form B11.

2.3.10 Verification of Drawings

2.3.10.1 Procedure

- Inspect the as fitted drawings, to ensure that all variations from the contract drawings have been recorded.

2.3.10.2 Results

- Record the results on Form B12.

2.3.11 Filling with Medical Air

- When an indefinite period may elapse before the system is taken into use, it should first be tested for particulate contamination, using medical air, as the test gas.

2.3.11.1 Procedure

- If the test is satisfactory, the system should be filled with medical air and left pressurised at pipeline distribution pressure.

2.3.11.2 Results

- If the results are satisfactory, they should be recorded on Form B14, which should be annotated to indicate that the system has been tested with medical air.

2.3.11.3 Special Connectors

- At the end of the contract period, the contractor should ensure that any special connectors are removed from site.

2.3.12 Purging and Filling with Specific Gas

2.3.12.1 General

The following should be carried out prior to purging and filling with the specific gas: -

a) all systems may be filled with their specific gases at the same time;

b) all previous tests should have been satisfactorily completed;

c) each pipeline system should be connected to its source of supply, with all AVSUs open;

d) all sources of test gas should be disconnected;

e) all special connectors and cylinders should be removed from site.

2.3.12.2 Procedure

The procedure is as follow: -

a) starting at atmospheric pressure (except for vacuum systems), fill each pipeline system to pipeline distribution pressure;

b) with the supply system on, purge each terminal unit with a known volume of gas at least equal to the volume of the pipeline being tested;

c) for vacuum systems, purging is not necessary;

d) leave each system at pipeline distribution pressure with the supply system connected.

2.3.12.3 Results

- Record on Form B13 that the systems have been filled.

2.3.13 Tests for Gas Identity

2.3.13.1 General

- All systems should preferably be tested at the same time. The previous tests must have been satisfactorily completed.

2.3.13.2 Procedure

- The tests should be carried out at all terminal units, using the medical gas analyser supplied by CMTD.

2.3.13.3 Results

- Record the results on Form B14.

2.3.14 System Taken into Use

When all the tests have been satisfactorily completed, the construction labels should be removed and the system may be taken into use.

3. MEDICAL GAS PIPING INSTALLATION

3.1 Quality of Medical Gas Piping

3.1.1 Medical Gas ('MG') tubing is designed to meet the stringent requirements laid down for the distribution of medical gases in hospital services. Two categories are recognized, viz: -

a) High pressure distribution; and

b) Low-pressure distribution.

Only 'MG' grade to be used.
The necessary of tube bore cleanliness cannot be over-emphasized.

3.1.2 Compliance with S.A.B.S. Specifications

All piping used for medical gas and vacuum installations must be of copper and in compliance with SABS 460 – 1975 (latest amendments).

All copper tubing must be in metric sizes and comply with the sizes as used for domestic plumbing services. "Half hard" piping is required up to 35mm outside diameter in straight lengths 5,5 or 3 metres long and hard drawn piping for all larger sizes in 5,5m straight lengths.

3.1.3 Physical Properties

3.1.3.1 High Pressure Applications

"Serpentines" may be in soft annealed copper coils. Manifolds shall be in hard drawn straight copper in exact lengths of 5,5 metres or 3 metres or as described in paragraph 3.7.

3.1.3.2 Low Pressure Applications

All tubes will normally be in the "half hard" condition as standard, up to 35mm outside diameter to facilitate bending but when specially needed and for larger sizes tubes can be specified to be in the hard drawn condition.

3.1.4 Freedom from Defects

Eddy current testing shall be carried out on all tubes to ensure freedom from physical defects as specified in ASTM Standard E243. Contractors may be required, at the discretion of the Secretary for Health, to obtain copies of documentation proving compliance with this requirement from the piping supplier.

3.1.5 Bore Cleanliness

3.1.5.1 General

All tubes shall be processed in such a manner that the bores are bright and clean. The use of carbon tetrachloride as a cleaning agent is not permissible. The measure of acceptable cleanliness shall be that specified in ASTM B.280. This requires that when the interior of a test sample of the tube is washed with trichloro-ethylene, or other solvent such as re-distilled chloroform or re-distilled trichloro-ethylene, the residue remaining upon evaporation of the solvent shall not exceed 0,0376 g/m2.

3.1.5.2 The following processes have to be undertaken on Medical Grade Copper Tubing before and after annealing at the manufacturer's premises.

a) Blowpipes clean with medically pure compressed air.

b) Use steam vapour aggravation next for cleaning inside of pipes.

c) Use a hot detergent for washing of the pipes internally.

d) Finally use a soft abrasive cleaning organic liquid. The final responsibility for ensuring that clean tubing is used in the installation rests with the Contractor. The above steps are required for all the tubing sizes in order to ensure compliance with paragraph 3.1.5.1.

3.1.6 Identification and Packing

3.1.6.1 Identification

All straight length tubes shall be identified by means of a continuous red line printed along the length of the tube, and shall have the ends protected with red plastic caps to prevent ingress of foreign matter during storage and transport.

All coiled tubes shall have their ends mechanically sealed and shall be marked M.G. All piping must be stored off the ground in a clean, safe area with the ends capped at all times.

3.1.6.2 Packaging

All straight length tubes shall be packed and delivered in timber cases of suitable size and capacity, normally half tonne (500kg) net.

All coiled tubes shall be packed in M.G. standard cardboard boxes and marked M.G.

3.2 Valves and Fittings

3.2.1 Valves

All valves are to be ball valves, with stainless steel bodies and balls and PTFE or Teflon seals.

They shall be suitable for a working pressure of 1000kPa gauge. Pipelines must be properly secured by holder bats in close proximity to the and on either side of each valve.

Valves shall be fitted into the pipeline by means of capillary hard soldered joints containing silver (see paragraph 3.3).

All types of valves tendered for shall be submitted for approval to the Secretary of Health prior to installation. The valve handle shall be the same colour as allocated to the gas.

3.2.2 Fittings

Bends and tees must be of wrought copper capillary fittings with internal stops.

Note that where pipe bends of a radius greater than 5 pipe diameters are required the tubing may be bent, provided that no flattening or thinning of the tube occurs at any point.

Bends in Class 2 tubing shall be free from flattening, buckling or thinning of the tube wall at any point. Form bends are permissible up to 28mm diameter. Elbow type fittings shall not be used unless for special purposes specified in the project specification.

Note further that makeshift methods of forming reducers, tees, joints, etc. Such as butt brazing of piping will under no circumstances be acceptable.

All clean and degreased valves and fittings shall be supplied to site in individual heat sealed plastic bags, which may only be opened just prior to installation.

3.3 Pipe Joints

Only capillary hard solder fittings for M.G. copper classes 0 and 2 tubing, shall be used up to 28mm outside diameter. Class 0 to be utilised in all larger sizes. The fittings shall be degreased similar to the Medical grade copper tubing.

Medical grade copper tubes joined by means of capillary fittings shall be jointed with hard solder with working temperatures between 600ºC and 700º, using: -

a) Self fluxing copper/phosphorous 7% minimum silver rod, as Afrox Silfos 15, or other approved.

b) When using self-fluxing hard solder, care must be taken to ensure that the joint is not overheated.

Alcohol or borax based mixtures or resin and similar paste fluxes may under no circumstances be used.

All screw joints must be sealed by tinning the male thread with soft solder.

3.4 Pipe Sizing and Routing

3.4.1 General

Special provision may be made in the building for holes through, and chases in the walls for piping by the building contractor, but all sleeves, brackets and fixings must be done in terms of the medical gas contract. Where the builder is to do the chasing, it will be the responsibility of the Medical Gas and Vacuum Contractor to point out to the builder in good time the exact position and size of openings and chases. The Medical Gas Contractor will beheld responsible at al times for the final positioning of outlets and conduits.

3.4.2 Pipe Sizing

The size of pipes for main runs and branch lines are as shown on the project drawings. The gas flow rates in MG piping must be as per the guidelines laid down by the U.K. Department of Health and Social Security in Hospital Technical Memorandum No. 22 and SABS 051. When ring mains are used these sizes can be reduced. Terminal connections to all outlet points, except as shown otherwise, may not be less than 10mm OD for oxygen, 12mm for vacuum and scavenge piping and 6mm for nitrous oxide.

3.4.3 Pipe Routes

Both horizontal and vertical pipe runs shall conform to the following sequence. From top to bottom and from left to right as appropriate. Oxygen, Nitrous Oxide, Vacuum, Low Pressure Air, High Pressure Compressed Air and Scavenging.

Horizontal pipe runs shall whenever possible not be lower than 2400mm above the floor level, unless they are suitably protected and accessible for maintenance staff.

Wherever practicable piping is to run on external walls below the eaves.

3.4.4 Wall Outlet Points

All wall outlet points shall be positioned 1,5m above finished floor level, the position in the room being shown on the project drawings.

3.5 Pipe Supports

Pipe runs in roof spaces, covered ways, under eaves and on the outside of buildings, i.e. where not in a space normally inhabited, shall be secured with “Fischer” clips. Other types of holder batts, which Tenderers may wish to offer, must first received the approval of the Secretary for Health. In all cases dissimilar metals must be isolated.

The centre distance of supports shall not exceed the following up to and including: -

Up to 10mm outside diameter pipe	-	1,00m
12 to 15mm outside diameter pipe	-	1,25m
22mm outside diameter pipe	-	1,80m
28mm outside diameter pipe	-	2,5m
35 to 76mm	-	see project design drawings

It is required that piping be run in support trays except when mounted against a wall.

Unistrut P4000 or equal approved supports shall be used for this duty. The support shall be fixed to the structure by means of at least two suitable brackets, expanding and/or fixing bolts. The pipes shall be fixed to the support by means of P1108 – 2025 series clamps or equal.

3.6 Protection of Piping

Where pipes are to be hidden (i.e. buried in walls or structures) they shall run in conduit or other suitable hard protective piping, or run in metal channels built in and flush with the finished wall surface, with suitable covers painted to match the wall finish.

Where pipes are to be run in a location where they may be damaged by trolleys, stretchers or similar mobile equipment, or where they may be interfered with by the general public or other unauthorized person, they shall be protected by encasement in pies or metal channels up to a heights of 2m. The route of the pipes shall be so selected that they are out of the reach of traffic and the general public.

Piping in ducts, roof spaces or above suspended ceilings shall be laid in Admiralty type cable trays. These cable trays must wherever possible be installed 150mm clear of any other piping or conduits run in the same roof space, unless otherwise authorized by the Secretary for Health.

All pipes in operating theatres shall be concealed or built in. Surface mounting in existing buildings will be considered in all other areas if sanctioned by the Secretary for Health.

Where the pipes pass through walls and ceilings, etc., they shall be sleeved and provided with wall plates, which shall be rust free and painted to match the general wall finish. Where several pipes, of different diameter are surface mounted side by side, the saddle centre distance appropriate for the smallest diameter pipe shall also be used for the larger pipes.

3.7 Brackets

Pipe support brackets and clamps shall be hot-dip galvanised to SABS 763.

4. CYLINDER GAS BANK MANIFOLDS AND PLANT

4.1 General

The central gas bank shall comprise two banks of gas cylinders main and reserve, connected to a manifold. Both main and reserve banks shall be connected to the system, in such a way that only one bank will supply the system at any one time.

When the operating bank becomes depleted or should the supply pressure fall, the reserve bank shall automatically come into use and the depleted bank shall be shut off. Electrically operated changeover panels are not acceptable.

All gas cylinder manifolds shall be of the duplex type with semi-automatic change over from one bank to the other and at the same time actuating the warning system.

Each bank shall supply the system through its own pressure reducer. A master pressure reducer shall ensure the correct line pressure no matter which bank is in operation. Each pressure reducer shall be fitted with a safety valve set to operate at 1 ½ times the working pressure and be vented to atmosphere.

The gas cylinder banks shall be placed in rooms indicated on the drawings and shall be of the capacities indicated in the project specification. On site manufacture of manifolds is not permitted. Oxygen and compressed air banks must preferably be in separate rooms, in order to avoid mixing of cylinders as these cylinders have identical bull-nose outlets.

Pressure gauges indicating the cylinder and supply line pressures shall be incorporated in the manifold and on al pressure reducers.

A service point (i.e. a medical gas outlet) shall be connected into the man line from each pressurized gas line in the plant room immediately after the main line valve. The service point height shall be about 1,5 meters above the finished floor level.

4.2 Manifold Materials

The fittings used to make up the manifold shall be forged bronze while the tubing shall be of heavy gauge copper. Pigtails shall be of annealed copper. All the high-pressure side equipment of the manifold shall withstand a test pressure of 40000kPa gauge.

Piping used in the manufacture of manifolds must be of medical grade piping and subject to the same cleaning procedures as for piping used in the gas reticulation (see paragraph 2.1.5).

Pressure test certificates must be supplied with all manifolds.

4.3 Manifold Equipment

The manifolds shall accommodate the number of cylinders specified and shall be arranged as shown on the drawings. Pigtails for connecting the manifold to the cylinders shall be long and flexible enough to allow easy connection to the cylinders without having to strain the tube. Each outlet for connecting the manifold to the pigtail shall have a header valve. Pigtails shall be connected to these valves with high-pressure gas connections and shall have standard bull-nose cylinder valve connections for cylinder coupling.

The regulator assembly, which shall operate on the semi-automatic changeover system, shall be as shown on the main drawings and shall include: -

i) Two pressure regulators set at 600 kPa gauge.

ii) Two pressure regulators set at 400 kPa for oxygen, nitrous oxide and compressed air manifolds.

The gas main diagrams show the position of pressure gauges. At least five pressure gauges must be installed: -

i) one high pressure gauge for each bank;

ii) one pressure gauge for each bank to indicate the intermediate pressure;

and

iii) one pressure gauge to indicate the low pressure on the distribution system.

All pressure gauges shall have a maximum reading of not more than twice normal working pressure.

A stop valve shall be provided on the low pressure outlet side of each regulator. The whole manifold regulator assembly etc., shall be securely bolted to a channel iron frame or directly to the wall and shall not be enclosed.

All piping must be surface mounted on the front of the frame. All new or replacement changeover panels are to be as “Afrox GPA Standard” or other approved.

All gas cylinders shall stand against a rack with individual safety chains (approximately 20 x 14 x 4mm diameter) for each cylinder to prevent these from falling over. These shall encircle the cylinders at about 2/3 of their height. Safety chains shall be secured with eye bolts and shall have a deep hood on the other end.

Safety valves shall be fitted after all pressure reducing stations, set as i) paragraph 4.7.

Safety and pressure reducing valve capacities shall be confirmed by means of manufacturer’s graphs, which are to be supplied by the contractor.

4.4 Cleaning

After assembly, the manifold, header, fittings and connections shall be blown out with medical compressed air and cleaned as specified in paragraph 3.1.5.2. A brass or copper plate shall be mounted on the manifold, stating test pressure, date of manufacture and manufacturer’s name.

A certificate shall be submitted to the Secretary for Health to this effect by the Testing Authority as outlined in paragraph 2.

4.5 Operating Instructions

Detailed, clearly printed instructions on how to operate the manifold and including any drawings, which may be necessary, shall be provided by the contractor. These shall be mounted in glass fronted frames fixed to the wall above the manifold by the contractor.

4.6 Accommodation

The accommodation required for the medical gas installation is as follows: -

i) A machine room for the medical air compressor, vacuum and scavenging units.
ii) A gas bank room, or partitioned area, for oxygen and nitrous oxide cylinders.
iii) A separate partitioned area for each of medical compressed air and each other medical gas that may be required.
iv) An empty gas cylinder store.
v) A full cylinder gas store.

Note that all plant room doors must be fully louvred with aluminium Trox (or other approved) weather louvres, complete with approximately 15 x 15mm bird screening.

Conveyor type rubber belting is required on floors where full or empty gas bottles are to be stored or connected to manifolds as well as at gas bottle off-loading points.

4.7 Safety and Relief Valve Settings

Safety valve and alarm settings shall be as per Figure 1 below (as per SABS 0224 – 1990)

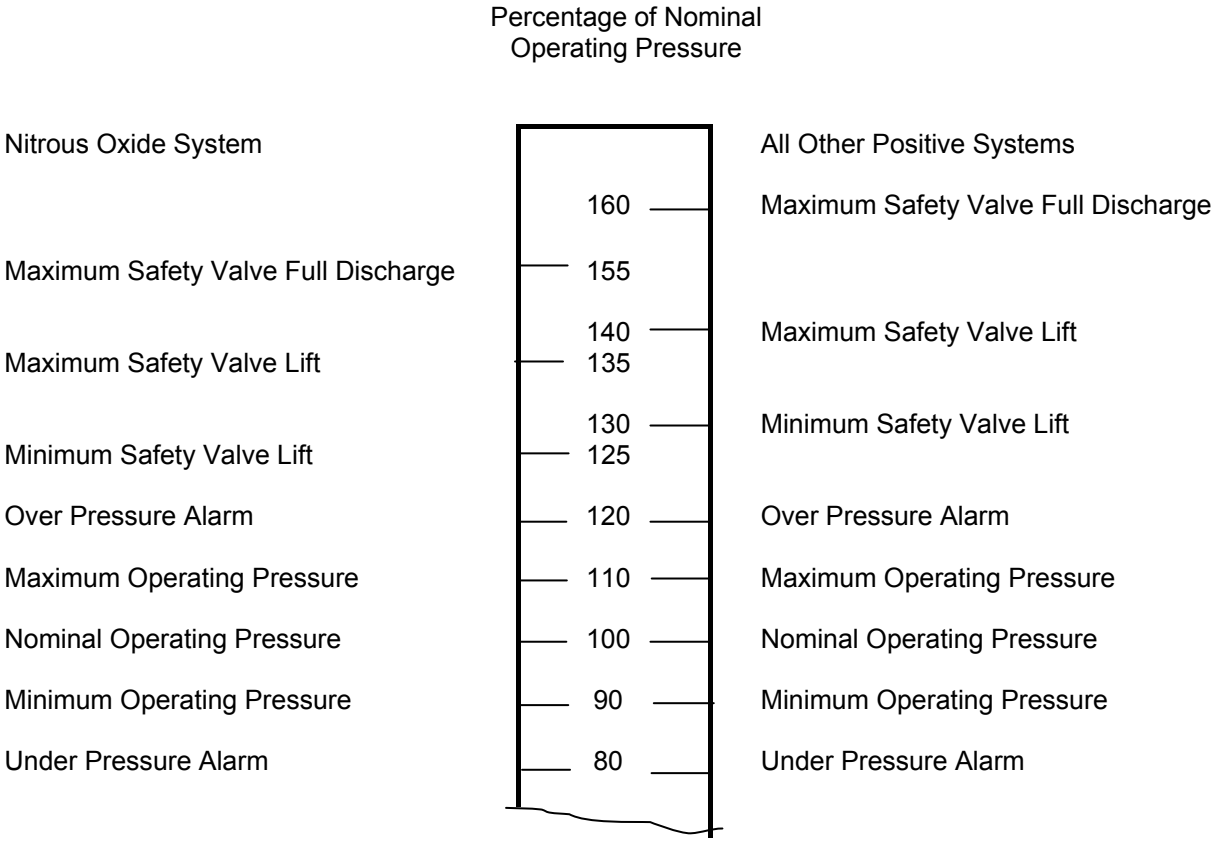


Figure 1 – Pressure Safety Valve and Alarm Pressure Settings

Note that safety valve exhaust piping is not required – the valve may vent into the plant room.

5. MEDICAL GAS WARNING SYSTEM

5.1 General

Visual and audible alarms will be a part of the medical gas system. The main function will be to indicate a malfunction as detailed in the warning light system described below.

A green light will indicate power continuity for the system. A “fault” on the banks for each “gas” shall be indicated by means of two RED lights, i.e. one for the left bank and one for the right. When a “fault” condition occurs, a RED light will come on and indicate whether the left or right bank is “faulty”, i.e. when pressure has fallen in that bank. The light indicating the fault will remain on until such time as the “fault” condition has been rectified, i.e. a depleted bank has been replaced with a fresh supply of full cylinders.

Simultaneously with the above light indication, an alarm, which may be a buzzer or siren, will sound at the slave alarm panel only. The alarm can be muted at the slave indicating alarm panel in the appropriate area, but must recur at fixed time intervals until the fault is rectified.

A slave indicating alarm panel shall be placed in an area, which is manned 24 hours a day. The position of this panel will be dictated by local conditions as specified in the project specification and drawings.

These areas are as follows: -

i) Reception Centre.

ii) Casualty and Main Theatre.

iii) Maternity Section.

5.1.1 Power Supply for Indicating Lights

The indicating lights shall be served by a 24 V DC supply and shall not have relays to actuate them. The system shall employ solid state circuitry. The cable shall be laid in trays reserved for medical gas installation and then fixed by means of saddles of an approved type, at one metre centres. A single phase 15 amp switch socket supply point shall be provided adjacent to the alarm panel, connected directly to the distribution board on a separate circuit by an electrical contractor.

6. MEDICAL GAS OUTLETS

All wall outlets shall be positioned 1,5m above floor level in positions shown on the drawings.

Where extensions are being carried out to existing hospital layouts, it is essential that the medical gas outlets are identical to those already in use. Fittings and outlets from the same supplier shall be used throughout the entire hospital.

Outlet points on all new hospital installations shall be flush mounted, non-protruding, quick coupling, self-isolating types with safety keyed connections, similar or equal to Heyer outlets to the configurations outlined in S.A.B.S. Specification 1409 – 1986 (outlet sockets and probes for medical gas and vacuum services used in Hospitals).

The probes must be marked the same colour as the cover plate. For new installations in existing hospitals where surface mounting of tubing and fittings is specified, outlet points shall be as above and be of the surface mounted type. The use of check valves incorporated in the outlet point is optional and depends on the project.

6.1 Indexing

The medical gas outlets and probes shall be indexed and mated such that under no circumstances can anything but the correct probe be inserted into the appropriate gas outlet valve; for example, it shall not be possible to insert a N_2O probe in an oxygen outlet or vice versa. The probes and outlets shall also be correctly identified. This shall be achieved by easily distinguishable shapes of probes and outlets and by permanent colouring of the probes and outlets. The outlets and probes must be as per the above S.A.B.S Specification.

6.2 Grouping

Each probe shall have permanently and clearly engraved upon it, the identification of the service, e.g. O_2, N_2O, Vac, Air and HP Air.

When a group of outlets are installed adjacent to each other the order from left to right as given above, shall always be followed. The outlets shall be such that the valve mechanism is easily accessible for maintenance purposes without having to unsolder pipe connections or break into the wall etc. Outlets shall receive the approval of the Secretary for Health, before installation.

Probes used in outlets under pressure shall have unidirectional flow.

6.3 Cover Plates

Each outlet shall have permanently and clearly engraved on the cover plate: -

The full word **Oxygen**

The full word **Nitrous Oxide**

The full word **Vacuum**

The full word **Air Low Pressure**

The full word **Air High Pressure**

Cover plates may be constructed of laminated glass fiber reinforced with resin and with silk-screen printed transfer laid in between.

6.4 Labelling

Each medical gas outlet is to be labeled with a 30 x 10 x 4mm thick plastic label, screwed or pop-rivetted to the outlet / or wall/ trunking immediately adjacent to the point. The label is to be the colour as per the gas (see colour coding item 12.).

For any new or replacement installation the Project Manager is to supply in writing for numbers from the Department of Health Head Office : Facilities Management, with full details of, and the locations of each outlet. Similarly, any redundant points are to be listed.

7. ISOLATING VALVES

7.1 Isolating valve cabinets shall be installed wherever shown on the drawings. They shall be of a size equal to that indicated for the pipeline in which they will be installed and shall be full bore. All valves except those mounted in the gas bank room or above suspended ceiling panels shall be housed as described in paragraph 5.3.

All isolating valves for gases and vacuum must be as specified in paragraph 3.2.1.

7.2 Positioning of Isolating Valves – Main and Branch Lines

Isolating valves serving outlets, which are located either singly or in groups, shall be placed in the same area as the outlet or outlets they are intended to serve and on the same floor. They shall not be placed in the roof or inaccessible spaces but high up on the wall under the ceiling where they can be reached by skilled maintenance staff. Where suspended ceilings are installed, the valves may be installed above the ceiling, and the applicable panel is to be marked “Medical Gas Isolating Valves Behind this Panel”. In such cases, valve boxes are not required. A vacuum bottle trap is to be installed with each set of valves.

7.3 Isolating Valve Boxes

7.3.1 General

The design of the valve boxes shall be similar to the distribution board used for electrical distribution in buildings, and shall be complete with architrave frame and flush piano-hinged door with catch. The valve boxes shall be large enough to accommodate the number of isolating valves, which shall serve the branch lines shown on the drawings.

Reference must be made to drawing number M040301.

Where surface mounted pipelines are specified, valve boxes shall be of the surface mounted type and the complete box is to be painted white. The box is to be butted up to the ceiling.

In the case of ceiling mounted valve boxes the frame shall be suspended from the concrete ceiling or roof timbers by adjustable hangers designed to suit the installation and which allows the frame to sit neatly and securely against the underside of the false ceiling or ceiling panel.

Valves boxes mounted in ceiling voids must in addition be locked with brass padlocks. All locks a particular installation must be keyed alike; keys must be handed to the Department’s Representative at the time of first delivery.

7.3.2 Valve Boxes – Paint Finish

All metal parts shall be degreased, rinsed, pickled, rinsed, phosphate, neutralized and then thoroughly dried. This process shall be followed up within 48 hours by white epoxy coating or one layer of a high quality zinc chromate primer, followed by two coats of good quality white alkyd based enamel. The minimum film thickness of the paint shall not be less than 63 micrometer.

Care shall be taken that all edges are properly covered by paint.

Paint used on boxes shall have an impact resistance of 2,20 J on 0,9mm mild steel plate and a scratch resistance of 2000g.

7.4 Valve Boxes – Markings

An engraved nameplate shall be fitted to the door of each valve box to read as follows: -

AUTHORISED PERSONS ONLY
MEDICAL GAS
ISOLATING VALVES
DO NOT CLOSE

Engraved isoprene nameplates shall be provided inside the cabinet to identify each valve. Each valve shall be painted according to the colour(s) specified in the colour code, paragraph 11. A notice indicating the room(s) fed shall be fixed inside each box. Room identification is to be obtained from the Architect and shall be by means of room number only – descriptive terms shall not be used. Valves boxes shall be installed as described in paragraph 5.3.1. Valve boxes and control cabinet doors shall have handles incorporating a mechanical door catch. Control cabinets and valve boxes shall be lockable with an electrical panel type square key. All isolating valves shall be Clearly and permanently labeled indicating the area served. This labelling shall be done by the Medical Gas Contractor.

8. MEDICAL COMPRESSED AIR

8.1 Required Pressures

There are two systems of medically pure compressed air in general use. System A which is to supply air to operating theatres for use on surgical instruments and System B, which is to supply air for respiratory purposes to wards and theatres.

System A units shall be High Pressure Air, regulated between 700 kPa and 800 kPa gauge and System B shall for Low Pressure Air, regulated at 400 kPa gauge.

8.2 Piping System

The medical compressed air system, so far as pipe runs, outlets, etc. are concerned, shall be as specified in the Project Specification. Pipes shall be of medical grade copper as specified in paragraph 2.1 above.

The air shall be free from oil moisture and bacteria. The pressure requirements for respiratory purposes are for use either as a driving gas for respiratory machines, or for air/oxygen mixing. The medical gas keyed probes shall be in accordance with S.A.B.S. 1409 – 1986 (Outlets Sockets and Probes for Medical Services used in Hospitals).

The medical compressed air shall be dried by bacterial filtration desiccant driers and refrigerated air driers as detailed in the Project Specification.

Starting at the plant room and immediately after the compressor, receiver, driers, filters, etc., the supply line shall be split and pressure reducing valves installed in each leg to produce the required pressure for the low pressure supply lines system B and high pressure lines system A. the pipelines shall each have relief valves to prevent excess pressure build-up in case of regulator failure.

Reference must be made to drawing number M040201.

8.3 Medical Air Compressors and Filtration

The compressor and filtration system to be used shall produce medically pure “oil free”, “moisture free” and “bacteria free” air (reference must be made to the Project Specification).

All air compressors shall be of air-cooled Stop – Start controlled type. Where a type A installation is required it shall be rated at 1000 kPa gauge working pressure. Units may be two stage compression type. Where a type B installation is specified it shall be rated at 700 kPa gauge working pressure. The output of the compressor and all other requirements shall be as specified in the Project Specification.

8.4 Compressed Air Receivers

The size of the air receiver will be given in the Project Specification. Two receivers are required. The receiver shall be of welded construction with dished ends, tested and stamped by an Independent Inspection Authority in terms of the Occupational Health and Safety (as amended) as stated in paragraph 1.6 of this specification.

It shall be fitted with a safety valve set at 70 kPa above the cutout point of the mercury control switch and a 75mm diameter dial pressure gauge with gauge cook. The working pressure shall be marked in red. The receiver shall be galvanised internally and externally. The tank shall be painted with a suitable metal primer undercoat and final enamel coat, colour White with Salmon Pink (A40) colour to S.A.B.S. 1091. The pipe connections to the receiver shall be fitted with sufficient loops and/or offsets to render them sufficiently resilient to absorb vibration.

8.5 Pressure Reducing Valves

There shall be two adequately sized pressure reducers in the supply line after the filters, which shall maintain a constant pressure in the line of 800 kPa gauge or 400 kPa gauge for system A and B respectively. The pressure reducer shall be such that it is possible to adjust the pressure by at least 140 kPa each way when required.

Pressure reducing valve stations shall be fitted with pressure gauges having dials of not less than 100mm diameter. The gauges are to be marked with red lines at the maximum pressure (on the face).

Manufacturer's flow charts must be supplied with the regulators.

8.6 Drives

The drives to be as per the Project Specification.

8.7 Bases

When erected on existing concrete floors, bases for mounting compressor units shall consist of a top reinforced concrete slab at least 75mm thick, preferably with a 40mm angle iron frame to form the top edges, trowelled to a smooth finish and coloured to suit the plant room floor with golden yellow/black diagonal stripes on all vertical edges. The compressor unit shall be mounted on anti-vibration mountings.

For new installations reference must be made to standard drawing M040401.

8.8 Emergency Cylinder Bank for Compressed Air

If required in terms of the Project Specification, an emergency stand-by cylinder bank shall be provided, using a Standard Manifold, as specified in paragraph 3.1. A back-up capable of 12 hour storage to the low pressure supply shall be supplied to operate in the event of a primary system failure.

8.9 Stand-By Facility

The compressor unit together with the entire medical gas and vacuum system shall be connected to the Hospital stand-by electrical power.

8.10 Medical Air Purity

The degree of purity of air to be achieved shall be in accordance with CKS 64.

8.11 Noise Level (For Compressed Air and Vacuum Plant)

The sound level shall be that portion of the sound spectrum attributable to the operation of the plant and shall not be objectionable in any of the wards, treatment areas, theatres, or any other occupied area of the Hospital.

9. VACUUM SYSTEMS

9.1 General

The vacuum shall be provided by two vacuum pumps driven by electric motors, with receiver and one set of controls. The pumps shall be of the reciprocating type, silent running, suitable for the purpose and be of a capacity as stated in the project specification. The vacuum shall not rise above 50 kPa absolute when the system is in full operation. The vacuum pump's electric motors shall be connected to the standby generator.

9.2 Operating Range

The pumps must each be capable of maintaining a vacuum of 60% of peak demand and will normally cycle between the range 20 kPa absolute maximum and 50 kPa absolute minimum. Diversity factors in accordance with good standard practice shall be applied in the sizing of the vacuum pump and piping.

A terminal point flow rate of 15 litres per minute with a diversity factor, varying from 20% to 100%, can be used for pipe sizing, depending on the location of the Hospital.

9.3 Installation

If required, the vacuum pump shall be fitted with a silencer of the expansion vessel type.

The vacuum pump shall be mounted as specified in paragraph 8.7. The pipe connections to the receiver shall be resilient. A bacterial filter is not required.

9.4 Pipe Connections to Vacuum Receiver and Distribution Network

The connections to the piping system shall be below the outlet of the receiver and placed on the side of the receiver. A test cock shall be provided on the receiver so that vacuum pump controls can be checked.

9.5 Vacuum Plant

The pumps must be suitable for drawing a vacuum down to 20 kPa absolute (-80 kPa gauge) and of a capacity as specified in the project specification.

The vacuum pumps must be air-cooled. A soft seated check valve shall be fitted in the line between the pump and the vacuum tank to prevent the possibility of leak back through the pump when not running. Exhaust gases shall be safely piped to the outside of the building and above the nearest adjacent building and away from any air intakes (not less than 6m).

9.6 Vacuum Tank

The vacuum tank, of the capacity specified in the project specification shall be of all welded construction and equipped with pump connections at the top. The tank shall be painted with a suitable metal primer, under coast and in all enamel coat in a yellow colour to S.A.B.S. 1091 colour number C67. The tank shall be fitted with a 100 kPa rupture disc in place of a safety valve.

9.7 Vacuum Bottle Traps

These shall be of the Afrox single valve, or other approved, type. Bottle traps are to be located in visible positions in service areas, as close as possible to the area(s) being served.

10. SCAVENGING SYSTEMS (Low Vacuum High Volume)

10.1 General

Exhalation of anesthetic gases from closed circuit absorbers, respirators and any anesthetic equipment shall be subjected to a separate suction system which shall remove the anesthetic gases and exhaled air to the outside of the building, released in such a position so as to avoid re-contamination through recirculation. The scavenging system shall operate on the low vacuum high volume principle.

The outlet point shall be positioned at the extreme right-hand position of all the medical gas and vacuum terminal points when required to be wall mounted or on the bottom surface of the gas pendant.

An operating pressure of 6 kPa gauge is required. It shall be capable of evacuating a least 25 ℓ/min at each outlet point. It shall overcome the system resistance. A dedicated piping system is required i.e. scavenging is to be done by means of a central turbine fan suction unit. The scavenging system shall have a capacity as detailed in the project specification.

Reference must be made to standard drawing M040305.

10.2 Scavenging System Layout

The ducting may be in P.V.C piping or copper tubing and all joints must be sealed airtight. Dampers must be provided in the ducting to balance the system (refer to drawing M040305).

The distribution plenum shall be made of rigid PVC and shall be sealed airtight. Such a system shall be connected to the theatre pendant or wall outlet. The fittings are all to be 30mm to ISO 5356 with 12mm terminal pipe sizing. The flexible tube must be installed on the pendant in a manner allowing for removal of the access plate without damage.

11. BOOM ARMS AND PENDANTS

11.1 General

Booms arms and pendants may be provided for medical gas outlets in operating theatres. They are to be positioned in the theatre to suit the specialist surgical teams as shown on the particular drawings. The fixed pendant shall be 1,9m clear above the finished floor level.

11.2 Installation

The method of mounting a pendant on concrete ceilings shall be shown on standard drawing M040302. The bolts for holding the mounting flange shall be cast into the concrete or shall be expanding bolts. A suggested method of mounting pendants where fibrous plaster or board ceilings are used is also shown on drawing M040302. If contractors wish to employ another method, then this method must be approved by the Secretary for Health prior to the work being put in hand.

11.3 Pipe and Electrical Connections

Whichever method of installation is used, contractors must ensure that easy removal of the pendant is possible, i.e. it shall be possible to disconnect all pipe and electrical connections to the pendant easily. The electrical supply to the pendant will be installed by an electrical contractor, the conduits terminating the end boxes. It will, however, be the responsibility of the medical gas contractor to arrange for the correct position thereof and to carry out the final connecting up of the electrical equipment.

12. **COLOUR CODING (As attached)**

Colours as per the attached table “Colour Coding for piped Services” are to be used.
Note that unless specified otherwise, medical gas piping is to be painted over it’s entire length.

COLOUR CODING FOR PIPED SERVICES

CONTENTS OF PIPING	PROPOSED
STEAM	PASTEL GREY (G54)
CONDENSATE	BRILLIANT GREEN (H10) WHITE
HOT DOMESTIC WATER	BRILLIANT GREEN (H10) CRIMSON (A03)
COLD DOMESTIC WATER	BRILLIANT GREEN (H10) CORNFLOWER (F26)
INDUSTRIAL HOT WATER (i.e. Primary Circuit, Central Heating etc.)	BRILLIANT GREEN (H10) GOLDEN YELLOW (B49)
FIRE WATER	SIGNAL RED (A11)
SEWAGE	BLACK
OXYGEN (Medical)	WHITE
NITROUS OXIDE (Medical)	ULTRAMARINE (F09)
VACUUM (Medical)	PRIMROSE (C67)
AIR (Medical) LOW PRESSURE HIGH PRESSURE	WHITE / BLACK WHITE / SALMON PINK (A40)
LPG	LIGHT STONE (C37)
COMPRESSED AIR (Industrial)	ARCTIC BLUE (F28)
CONDITIONED AIR FLOW	ARCTIC BLUE (F28) WHITE
CONDITIONED AIR RETURN	ARCTIC BLUE (F28) WHITE
VENTILATION AIR FLOW	ARCTIC BLUE (F28) LIGHT STONE (C37)
VENTILATION AIR EXHAUST	ARCTIC BLUE (F28) LIGHT STONE (C37)
CHILLED WATER	BRILLIANT GREEN (H10) PEACOCK BLUE (F08)
CONDENSER WATER	BRILLIANT GREEN (H10) SALMON PINK (A40)
REFRIGERANT	LIGHT GREY (G29)
DIESEL	GOLDEN BROWN (B13) WHITE
TRANSFORMER OIL	GOLDEN BROWN (B13) CRIMSON (A03)
FUEL OIL	GOLDEN BROWN (B13) + LABEL

All piping is to be labelled (as per SABS) including the direction of flow at maximum 3m intervals or at all changes of direction, T’s and wall penetrations.

APPENDIX A

Testing, commission and filling for use; Forms to be completed during testing and commissioning of piped medical gases systems

	Form
Summary of Tests	B0
Carcass Tests	
Labelling and Marking	B1
Sleeving and Supports	B1
Leakage Test	B1
Cross Connection Test	B2
System Tests	
Leakage Test	B3
Vacuum Leakage Test	B4
Area Valve Service Units - Closure and Zoning Tests	B5
Cross Connection Test	B6
Functional Tests of Terminal units and NIST Connectors	B7
Design Flow Performance Test	B8
Sources of Supply	B9
Pressure Safety Valves	B10
Warning Systems	B11
Verification of Drawings	B12
Purging and Filling	B13
Gas Identification	B14
Permit to Work	
Permit to Work	B15

Medical Gas Pipeline Tests Form B0 (Sheet of Sheets)

Hospital _____ Facility Audit Building No. _____

Project Description _____ Date_____

Summary of Tests

This is to Certify that the following Tests have been carried out: -

System	Form	Test Carried Out Satisfactorily
Carcass Tests		
Labelling and Marking	B1	
Sleeving and Supports	B1	
Leakage Test	B1	
Cross Connection Test	B2	
System Tests		
Leakage Test	B3	
Vacuum Leakage Test	B4	
Area Valve Service Units - Closure and Zoning Tests	B5	
Cross Connection Test	B6	
Functional Tests of Terminal Units and NIST Connectors	B7	
Design Flow Performance Tests	B8	
Sources of Supply	B9	
Pressure Safety Valves	B10	
Warning Systems	B11	
Verification of Drawings	B12	
Purging and Filling	B13	
Gas Identification	B14	
Permit to Work Form	B15	
Construction Labels Removed		

Project Leader

Position _____ Signed _____

Date _____ Name _____

All appropriate tests satisfactorily carried out. System may now be taken into use.

Competent Person (Department of Health) _____

Status _____ Signed _____

Date _____ Name _____

Leakage Test, Labelling and Marking, Sleeving and Supports Form B1 (Sheet of Sheets)

Hospital _____ Facilities Audit Building No. _____

Project Description _____ Date _____

This is to certify that a LEAKAGE test in accordance with paragraphs 5.3 - 5.6 was carried out on the piped system on this scheme and that during the test, a pressure, as shown in column 2 below, was held as follows. A certified gauge number ____ was used.

Section Tested (1)	Test Pressure (2)	Hours On Test (3)	Pressure Drop (kPa) (4)	Pressure Drop % hr (5)	Pass/Fail Specification 0.025% (6)	Labelling & Marking as Para 2.2.1 Yes/No (7)	Sleeving & Supports as para 2.2.2 Yes/No (8)

Part 2 - Links Between Systems

For the purpose of carrying out this test, the following links have been made: -

_____

_____

This is to certify that the above tests have been carried out and that the following links have been removed: -

_____

_____

Contractor's Representative

Name _____ Position _____

Sign _____

Project Leader

Name _____ Position _____

Sign _____

Cross Connection Test Form B2 (Sheet of Sheets)

Hospital _____ Facilities Audit Building No _____

Project Description_____ Date _____

This is to certify that a CROSS CONNECTION test, in accordance with paragraph 2.2.4 was carried out on the following medical gas pipeline systems: -

No Cross Connections between these Systems were found.

Contractor's Representative

Name _____ Position _____

Sign _____

Project Leader

Name _____ Position _____

Sign _____

Leakage Test from Total Compressed Gas System Form B3 (Sheet of Sheets)

Hospital _____ Facilities Audit Building No _____

Project Description _____ Date _____

This is to certify that a LEAKAGE test in accordance with paragraphs 2.2.1 was carried out on the piped system on this scheme and that during the test, a pressure of _____ kPa was held for _____ hours with a pressure drop of _____ kPa.

Section Tested	No of Terminal Units (n)	Hours On Test (h)	Volume Of System (V)	2n/h ___ V	Pressure Drop Found (kPa)	Pass/ Fail

Contractor's Representative

Name _____ Position _____

Sign _____

Project Leader

Name _____ Position _____

Sign _____

Competent Person Department of Health

Name _____ Position _____

Sign _____

Leakage into Total Vacuum System Test Form B4 (Sheet of Sheets)

Hospital _____ Facilities Audit Building No_____

Project Description_____ Date _____

This is to certify that a LEAKAGE test in accordance with paragraphs 2.3.2 was carried out on the piped vacuum system at a system pressure of _____ kPa. The pressure increase after 1 hour was _____ kPa (max 10 kPa).

Section Tested	No of Terminal Units (n)	Hours On Test (h)	Volume Of System (V)	$\frac{2n/h}{V}$	Pressure Drop Found (kPa)	Pass/ Fail

Contractor's Representative

Name _____ Position _____

Sign _____

Project Leader

Name _____ Position _____

Sign _____

Competent Person Department of Health

Name _____ Position _____

Sign _____

Area Valve Service Units - Closure and Zoning Tests Form B5 (Sheet of Sheets)

Hospital _____ Facilities Audit Building No _____

Project Description_____ Date _____

This is to certify that CLOSURE and ZONING of the AVSUs was tested in accordance with paragraphs 2.3.3.1 – 2.3.3.2 on the pipeline system as follows: -

AVSU Number	Test Pressure (kPa)	Downstream Pressure Change After 15min (kPa)	Terminal Units Controlled (Total No)	Terminal Unit Labelling

Contractor's Representative

Name _____ Position _____

Sign _____

Project Leader

Name _____ Position _____

Sign _____

Witnessed on Behalf of _____

By _____ Status _____

Signed _____ Date _____

Cross Connection Test Form B6 (Sheet of Sheets)

Hospital _____ Facilities Audit Building No _____

Project Description_____ Date _____

This is to certify that a CROSS CONNECTION test, in accordance with paragraph 2.3.4 was carried out on the following medical gas pipeline systems: -

Contractor's Representative

Name _____ Position _____

Sign _____

Project Leader

Name _____ Position _____

Sign _____

Witnessed on Behalf of _____

By _____ Status _____

Signed _____ Date _____

Functional Tests of Terminal Units Form B7a (Sheet of Sheets)

Hospital _____ Facilities Audit Building No _____

Project Description_____ Date _____

(In accordance with the Contract Specification and paragraphs 2.3.5).

System _____

Specified Flow _____ L/min Specified Pressure Drop _____ kPa

Outlet Unit Number(s)	Room Number	Specified Flow Achieved Yes/No	Specified Pressure Drop Achieved Yes/No	Mechanical Function	Gas Specificity

Contractor's Representative

Name _____ Position _____

Sign _____

Project Leader

Name _____ Position _____

Sign _____

Witnessed on Behalf of _____

By _____ Status _____

Signed _____ Date _____

Functional Tests NIST Connectors Form B7b (Sheet of Sheets)

Hospital _____ Facilities Audit Building No _____

Project Description_____ Date _____

(In accordance with the Contract Specification).

System _____

NIST Gas	Outlet #	Location or Identification	Room Number	Gas Specificity Pass/Fail	Self-Sealing Adequate / Inadequate

Contractor's Representative

Name _____ Position _____

Sign _____

Project Leader

Name _____ Position _____

Sign _____

Witnessed on Behalf of _____

By _____ Status _____

Signed _____ Date _____

Design Flow Performance Tests Form B8 (Sheet of Sheets)

Hospital _____ Facilities Audit Building No _____

Project Description_____ Date _____

(In accordance with paragraph 6.3.6).

System _____ System design flow _____ (L/min)

Terminal Unit test flow _____ (L/min) Test Pressure _____ (kPa)

Minimum gauge pressure allowed _____ (kPa)

Outlet Unit No	Room No	Specification Met (✓)	Terminal Unit No	Room No	Specification Met (✓)	Terminal Unit No	Room No	Specification Met (✓)

Contractor's Representative

Name _____ Position _____

Sign _____

Project Leader

Name _____ Position _____

Sign _____

Witnessed on Behalf of _____

By _____ Status _____

Signed _____ Date _____

Sources of Supply Form B9 (Sheet of Sheets)

Hospital _____ Facilities Audit Building No _____

Project Description_____ Date _____

This is to certify that the following sources of supply have been tested according to paragraph 2.3.7 and the attached sheets and found to comply with the specification.

Source of Supply	Contractor's Representative Name/Signature	Contract Supervising Officer Name/Signature
Manifold		
Manifold		
Manifold		
Liquid Oxygen Plant		
Air Compressor		
Vacuum Plant		
Oxygen Concentrator		

Witnessed on Behalf Of _____

By _____ Status _____

Signed_____ Date _____

Pressure Safety Valves Form B10 (Sheet of Sheets)

Hospital _____ Facilities Audit Building No _____

Project Description_____ Date _____

The pressure safety valves fitted tot he pipeline systems have been inspected together with their certification and are in accordance with the contract specification and paragraphs 6.26 - 6.27.

Location	Valve Number	Position	Pipeline Distribution Pressure (A)	Certified Discharge Pressure (B)	B/A (%)

If certificates are not provided, do not sign.

Contractor's Representative

Name _____ Position _____

Sign _____

Project Leader

Name _____ Position _____

Sign _____

Witnessed on Behalf of _____

By _____ Status _____

Signed _____ Date _____

Warning Systems Form B11 (Sheet of Sheets)

Hospital _____ Facilities Audit Building No _____

Project Description_____ Date _____

This is to certify that the WARNING SYSTEMS on the following medical gas pipeline systems have been tested in accordance with paragraph 2.3.9 as follows: -

System	O2	N2O	Medical Air HP	Medical Air LP	VAC
Specified Warning Pressure					
Observed Warning Pressure					
Warning Given					
Return to Normal					
Marking					
All Functions on all Stations					
Stand-by Power					

Contractor's Representative

Name _____ Position _____

Sign _____

Project Leader

Name _____ Position _____

Sign _____

Witnessed on Behalf of _____

By _____ Status _____

Signed _____ Date _____

Verification of Drawings Form B12 (Sheet of Sheets)

Hospital _____ Facilities Audit Building No _____

Project Description_____ Date _____

This is to certify that in accordance with paragraph 2.3.10, the as fitted drawings of the following systems record all variations from the contract drawings: -

System	Outlet Numbers	Drawing Numbers	Contractor's Representative Status/Name	Contract Supervising Officer Status/Name	Date
O2					
N2O					
Medical Air HP					
Medical Air LP					
VAC					

Contractor's Representative

Name _____ Position _____

Sign _____

Project Leader

Name _____ Position _____

Sign _____

Witnessed on Behalf of _____

By _____ Status _____

Signed _____ Date _____

Purging and Filling

Form B13 (Sheet of Sheets)

Hospital _____

Facilities Audit Building No _____

Project Description_____

Date _____

This is to certify that medical gas systems have been purged and filled with the working gases in accordance with paragraphs 2.3.11 and/or 2.3.12 as follows: -

Action	O2	N2O	Medical Air HP	Medical Air LP	VAC
Special Connectors/ Cylinders removed from site					
Filling					
Warning Given					
Purging all Terminal Units					
Venting					

Contractor's Representative

Name _____ Position _____

Sign _____

Project Leader

Name _____ Position _____

Sign _____

Witnessed on Behalf of _____

By _____ Status _____

Signed _____ Date _____

Gas Identification and Purity Form B14 (Sheet of Sheets)

Hospital _____ Facilities Audit Building No _____

Project Description_____ Date _____

This is to certify that the identity of the gas at all terminal units has been tested.

Outlet Label	Outlet Number	Test For	Specification Limit	kPa	Result
Oxygen		O2	Not less than 99.0%		
		N2O	O		
N2O		O2	O		
		N2O	Not less than 99.0%		
Medical Air HP		O2	21 ± 1%		
		N2O	O		
Medical Air LP		O2	21 ± 1%		
		N2O	O		
Vacuum		Suction	Suction Present		

All % are v/v.

Project Manger Name _____

Signed _____ Date _____

Competent Person Name _____

Signed _____ Date _____

Contractor Name _____

Signed _____ Date _____

Clinical Technician Name _____

Signed _____ Date _____

Witnessed on Behalf Of _____

By _____ Status Anesthetist/Medical Office

Signed_____ Date _____

Permit to Work for Piped Medical Gasses
Medical Compressed Air
Medical Vacuum Installation

Form B15

Hospital _____

Area(s) of Hospital _____

_____

Description of Work _____

_____

Commencement Date/Time _____

Permission to Commence _____
Competent Person

_____
Doctor/Sister
In Charge of Area(s) Affected

Work Completed _____
Person in Charge of Execution
(Contractor/Fitter)

Remarks _____

_____

_____

_____

Tests and authorization for use after completion _____
Competent Person

_____
Date

_____
Anesthetist/Medical Officer

_____
Date

APPENDIX B

GAS PRESSURE VARIATION WITH TEMPERATURE

General

1. Tests are specified for leakage of the pipeline carcass and the pipeline systems. During these tests pressure changes may occur which are caused by temperature changes rather than leakage.

2. Pressure changes due to temperature difference may be calculated according to the Gas Laws.

3. It is assumed that the temperature in the pipeline is uniform in all branches.

Calculation

4. The change in gas pressure with temperature is as follows: -

5. P1/T2 = P2/T2, where P1 and P2 are the initial and final absolute pressure of a fixed volume of gas and T1 and T2 are the initial and final absolute temperatures.

6. Therefore $P2 = \frac{P1 \times T2}{T1}$

7. Care must be taken to express pressure and temperature in absolute values.

8. Pressure is normally expressed in gauge pressure. Absolute pressure = gauge pressure + atmospheric pressure.

9. Temperature is normally expressed in ºC. Absolute temperature (ºK) = 273 + temp in ºC.

Examples

10. The carcass of a medical air pipeline is tested for leakage at a working pressure of 14.0 bar gauge pressure. The temperature is 13ºC at the beginning of the test and 17ºC at the end of the test.

P1 = 14.0 + 1.0 = 15.0 bar
T1 = 273 + 13 = 286 ºK
T2 = 273 + 17 + 290 ºK

Therefore $P2 = \frac{15 \times 290}{286}$ = 15.21 bar absolute

that is, gauge pressure should read 14.21 bar at the end of the test, assuming that no leakage has occurred.

APPENDIX C

PRESSURE DROP TEST DEVICE

General

1. Special test devices are required to measure the pressure at specified flows at each terminal unit.

2. Suitable test devices are commercially available or may be constructed in accordance with the outline specification given below.

Measurement Principle

3. Flow at a specified pressure may be measured either with a calibrated orifice or with a flow meter.

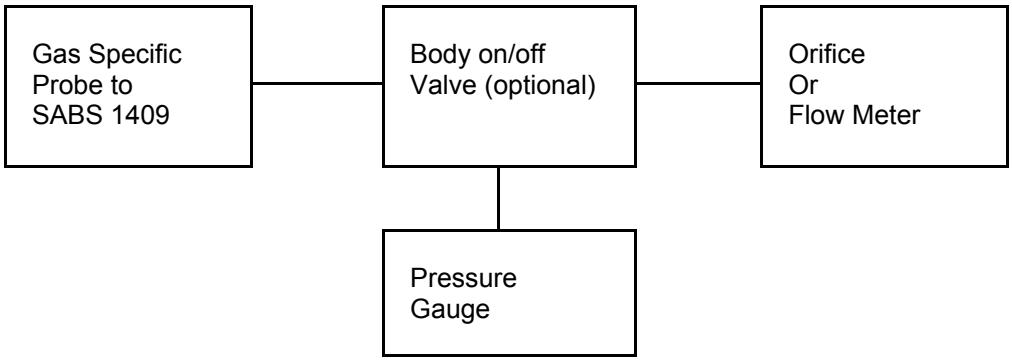
4. Pressure may be measured with a bourdon gauge.

5. A gas specific probe to BS5682 should be used to connect the device to the terminal unit.

6. The test device is connected to the terminal unit by the gas specific probe and the pressure at the specified flow is read on the gauge.

Functional Requirements

7. The test device should consist of the following components: -



8. The body may be of a design which allows exchange of the following components: -

   a) Gas specific probes;

   b) Calibrated orifices;

   c) Pressure gauges.

9. An on/off valve may be incorporated into the body.

10. The complete assembly should be tested for leaks.

11. Where it would be impractical to use gas specific probes, it is permissible to use a specially designed universal probe, provided it is impossible for such a probe to be improperly used on medical equipment. The special probe should be clearly marked **'test'** only.

Test Probes for Gas Specificity

12. The gas specific probe for each service should be as specified in SABS 1409.

Orifices

13. The orifices should be as follows: -

Service	Flow (1/min)	Min gauge Pressure (kPa)	AMAL jet no.
Surgical air 700 kPa	350	700	130
All other compressed gases	40	380	130
Vacuum	40	40mm Hg (below atmospheric pressure)	*

* A specially calibrated orifice may be used to measure flow under vacuum.

14. These devices should be checked against a flow meter before use.

Flow Meter

15. A bobbin flow meter calibrated to a flow of 40l/min may be used to measure flow under vacuum.

Pressure Gauge

16. A 50 mm bourdon gauge with an appropriate full scale reading and interval should be used as follows: -

Test Pressure kPa	Scale	Scale Interval
400	0 - 7 bar	0.1 bar
700	0 - 11 bar	0.5 bar
Vacuum	0 - 760 mm Hg	500 mm Hg

Note: 1 bar = 100 kPa