# Scottish Health Technical Memorandum 2022

## Dental compressed air and vacuum systems

## Supplement 1



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# Executive summary

This Supplement provides advice and guidance on the specific requirements for compressed air and vacuum systems for use in dental hospitals, clinics and surgeries.

The Supplement should be followed for all new installations and refurbishment; existing installations should be assessed for compliance with this Supplement. A plan for upgrading the existing systems should be prepared, taking into account the priority for patient and staff safety and compliance with statutory requirements which may have become effective subsequent to any existing installations. Managers will need to liaise with dental and estates colleagues and take account of other guidance published by the Department of Health in order to assess the system for technical shortcomings.

The guidance given in SHTM 2022 should generally be followed for these systems, except where modified in this Supplement.

Dental hospitals, clinics and surgeries require provision of compressed air to power dental instruments and a vacuum system to remove detritus from the operation site.

Dental air is usually supplied via a compressor fitted with a filtration and dryer system. This ensures that the air is clean and dry, minimising the risk of contamination of the system by micro-organisms, and improving the efficiency of dental instruments. Wet and dirty air will eventually lead to damage and corrosion of instruments. The pipeline distribution system for dental air can be either copper or nylon. In systems serving more than two or three dental chairs, however, copper is preferred, in accordance with SHTM 2022 Part 1, 'Design, installation, validation and verification'.

This document gives guidance on dry vacuum systems because it is considered that such systems offer greater safety, simplicity and cost-effectiveness in operation. The pipeline distribution system for dental vacuum and exhaust lines can be either copper or polythene and polypropylene. The exhaust from the vacuum system will need to be silenced, sited outside at roof level away from air intakes, opening windows etc and be clearly labelled. The design and installation of the vacuum system's water supply and effluent discharge should take account of the water byelaws, in particular the need to prevent contamination, waste and undue consumption.

Accommodation for dental compressor and vacuum pumps should follow the general principles given in SHTM 2022 Part 1, 'Design, installation, validation and verification'.

# Contents

# 1. Scope

1.1 This Supplement to SHTM 2022 covers the design, installation, validation and verification and maintenance of compressed air and vacuum systems for use in dental hospitals, surgeries and clinics.

1.2 Other guidance on the provision of medical gas pipeline systems (MGPS) is also given in the Scottish Hospital Planning Notes and Health Building Notes. Guidance on ventilation will also be found in SHTM 2025, the Health Building Notes and Scottish Hospital Planning Notes.

1.3 The guidance given in SHTM 2022 should generally be followed for these systems, except where modified in this Supplement.

1.4 A compressed air system and a vacuum system are installed to provide safe, convenient and cost-effective systems for use by dental staff at the point of use. They reduce the problems associated with portable cylinders and suction systems, particularly patient and staff safety, porterage and storage.

1.5 The guidance given in this Supplement should be followed for all new installations and refurbishment.

1.6 The guidance given in this document should be implemented in respect of patient and staff safety, and compliance with statutory requirements. Existing installations should therefore be assessed for compliance with this Supplement. A plan for upgrading the existing systems should be prepared, taking account of the priority for patient and staff safety and compliance with statutory requirements which may have become effective subsequent to any existing installations. Managers will need to liaise with dental and estates colleagues and take account of other guidance published by the DoH in order to assess the systems for technical shortcomings.

1.7 The requirements in respect of compliance with statutory regulations apply to all premises where dental procedures are carried out, regardless of whether they are NHS or private premises.

1.8 This SHTM covers the policies, principles, responsibilities of personnel, and the operation of the system by users, estates staff, quality controller etc.

1.9 It also covers the design considerations, validation and verification, operational management and permit-to-work procedures for dental compressed air and vacuum systems.

1.10 Wherever possible, the appropriate British or equivalent European or international standards should be used.

# 2. Management responsibilities

## Statutory requirements

2.1 It is the responsibility of the owners and occupiers of premises, general managers and chief executives to ensure that their premises and the activities carried out within those premises comply with all statutory requirements. The statutory requirements for MGPS are covered in the 'Operational management' Part 2 of SHTM 2022.

2.2 Attention is particularly drawn to the following statutory requirements:

a. the Control of Substances Hazardous to Health (COSHH) Regulations 1999;

b. the Pressure Systems Safety Regulations 2000.

2.3 Guidance on health and safety law for dental practice is given in Advice Sheet A3 published by the British Dental Association Advisory Service.

## COSHH Regulations 1999

2.4 These regulations apply to substances that have been classified as being very toxic, harmful, corrosive or irritant. Specific duties are placed upon employers and employees in relation to these substances, which have been assigned either maximum exposure standards (MES) or Occupational Exposure Standards (OES) as listed in EH40 published by the Health and Safety Commission.

2.5 Substances classified as hazardous to health which are likely to be encountered in the dental clinic include anaesthetic agents, glutaraldehyde, mercury and methyl methacrylate.

2.6 The anaesthetic agents nitrous oxide, enflurane, halothane and isoflurane have been assigned OESs effective from 10 January 1996.

2.7 Guidance on controlling the exposure to anaesthetic gases in dental surgeries is given in SHTM 2022 volumes 1 and 2, and also in EL(96)33).

2.8 Guidance on controlling exposure to the other substances is given in the BDA Advice Sheet A3, *Health and Safety Law for Dental Practice*.

2.9 The design and installation of the vacuum system should take into consideration the need to control exposure to amalgam and other particles and the method of safe disposal of these substances. Guidance on the design of these systems is given in Chapter 5, 'Dental air'.

## Sewage (Scotland) Act 1968

2.10 Under this Act it is illegal to make a discharge of trade effluent to "controlled waters" via a surface water drain without the prior consent of the Water Authority and the Scottish Environmental Protection Agency. Special provision should be made for the safe and efficient separation and discharge of amalgam before discharge to the foul water drain. Guidance is given in Chapter 4 on the design of these systems.

## Pressure Systems Safety Regulations 2000

2.11 These regulations require that a written scheme of examination be prepared by a competent person as defined by the regulations for each pressure system.

2.12 This will include the compressed air system in dental surgeries – the air receiver is a pressure vessel.

2.13 The term "competent person" is defined in the regulations, and guidance is also given in SHTM 2022 Part 2, 'Operational management.'

2.14 Some of these regulations do not apply for small systems where the stored energy in the system is less than 250 bar-litres.

2.15 For all systems – including those of less than 250 bar-litres – there is a requirement for proper maintenance in accordance with each of the manufacturer's recommendations.

## Functional responsibilities

2.16 Over the last five years there have been profound changes in the management philosophy of the NHS. Many hospitals have become self-governing trusts, many community dental clinics are now part of the community trust, and there are many high street dental practices which provide services to private patients only.

2.17 Where dental care is provided within a hospital or trust, the chief executive or general manager has the formal responsibility for the MGPS and the dental compressed air and vacuum.

**NOTE:** For a private practice, the formal responsibility for these systems rests with the senior partner, partners or principal(s) in the practice.

2.18 The approach adopted in this SHTM for the MGPS is to identify the distinct functions that need to be allocated and the responsibilities that go with them. The titles given in the SHTM are therefore generic.

2.19 In all cases where an MGPS is installed, it is essential to identify an Authorised Person (MGPS) who is responsible for the day-to-day management of the pipeline system.

2.20 Obviously this would be too detailed for the majority of dental compressed air and vacuum systems. The same principles should, however, be applied to the dental systems in order to ensure the integrity of the system and patient safety.

2.21 Where dental compressed air and vacuum systems are installed in addition to MGPS, as would be the case in a dental hospital, the Authorised Person should also be responsible for the dental systems.

2.22 Where only dental compressed air and vacuum systems are installed, a simplified operational policy should be prepared which should identify a competent person who will be responsible for the day-to-day management of the systems and will ensure that the appropriate maintenance is satisfactorily carried out.

**NOTE:** This competent person is not the same as the competent person as defined in the Pressure Systems Safety Regulations 2000; nor would it necessarily be the same person termed a Competent Person (MGPS) as defined in SHTM 2022 Part 2, 'Operational management'. To avoid confusion, it might be helpful to refer to this person as Competent Person (Dental).

2.23 The role and responsibilities of the Authorised Person (MGPS) are defined in SHTM 2022, 'Operational management'.

2.24 Where dental air and vacuum systems only are installed (that is, no MGPS), it may not be necessary to implement the full permit-to-work system for MGPS. It is nevertheless essential that adequate records be maintained of maintenance actions, modifications, etc.

## Training

2.25 It is essential that all personnel who use or maintain the dental compressed air and vacuum systems have a sound general knowledge of the principles, design and safety procedures, and have received training.

2.26 A training programme should be set out in the operational policy, and records should be kept of all training carried out. This should be subject to annual review.

2.27 All Authorised Persons (MGPS) should have received specific training as set out in SHTM 2022.

2.28 The competent person designated as responsible for the dental systems should ensure that only adequately trained personnel are allowed to carry out maintenance on these systems.

# 3. General principles

## General statement

3.1 In a dental surgery or clinic, compressed air is provided as the power source for the dental instruments; vacuum is required to remove detritus from the operation site.

3.2 The performance requirements of these systems differ from those for medical air and vacuum, and they are usually provided in addition to the medical gas systems. To avoid confusion they will be referred to as dental air and dental vacuum.

3.3 The dental air and vacuum must be supplied from a separate source via dedicated pipeline systems; the medical and surgical air and vacuum system should not be used to provide dental air or dental vacuum.

**NOTE:** In some cases, it may be acceptable to provide the dental air for the surgical instruments from the medical air system, providing the system has been designed to cope with this demand.

3.4 Where medical gas pipelines are installed in a dental surgery or clinic, the guidance given in SHTM 2022 should be followed.

3.5 Dental air and vacuum systems may be used in the dental laboratory provided the system has been specifically designed to cope with this demand.

3.6 Separate installations should be provided for pathology applications.

3.7 Where anaesthetics are administered, a risk assessment will need to be carried out in order to comply with the requirements of COSHH. Guidance on this is given in SHTM 2022, parts 1 and 2, and also in EL(96)33.

## Quality requirements for dental air

3.8 Dental air should be clean and dry in order to minimise the risk of contamination of the system by micro-organisms, and to improve the efficiency of the dental instruments. Wet and dirty air will eventually cause corrosion and lead to damage of instruments.

3.9 The quality of the dental air should be the same as for medical air, except that it is not necessary to achieve a dew-point of -40°C at atmospheric pressure; a dew-point of -20°C is adequate.

3.10 The quality requirements for dental air are given in Table 1.

**Table 1: Quality specification for dental air**

| Parameter | Specification |
|---|---|
| Oxygen | 20.9 ± 1.0% |
| Nitrogen | 78.0% by inference |
| Particulate contamination | Practically free from visible particles in a 75 litre sample |
| Water content | Equivalent to a dew-point of –20°C at atmospheric pressure |
| CO | <5 ppm v/v |
| $CO_2$ | <500 ppm v/v |
| Oil content (droplet or mist) | <0.5 mg/m$^3$ |
| Odour | none |

Note: The odour threshold is approximately 0.3 mg/m$^3$

3.11 Guidance on testing procedures is given in SHTM 2022.

3.12 The quality of the dental air should be tested annually (or more frequently if specified by the manufacturer or if requested by the quality controller) at the plant test point using the test equipment and procedures specified in SHTM 2022 Part 1, 'Design, installation, validation and verification'.

3.13 It will be necessary for both dryers and filters to be installed in the dental air system in order to achieve the quality specified in Table 1; details of these systems are given in paragraphs 5.29 to 5.41.

3.14 Bacterial filters should be included in the dental air system to reduce the risk of delivering spores or other infectious material to vulnerable patients; filtration requirements are given in paragraphs 5.42 to 5.45.

3.15 Micro-organisms can penetrate a bacterial filter if the material becomes wet. It is essential that the dryness of the dental air supplied to a bacterial filter is checked regularly – preferably with an in-line monitor – to ensure that the filter does not become wet.

## Pipeline distribution system design

3.16 The design process for dental air and vacuum is similar for medical air and vacuum, except that the performance criteria will be different.

3.17 The following general information is required in order to design the dental air and vacuum system:

a. a schedule of provision of dental chairs and medical air terminal units (where applicable);
b. design flow-rates and pressure requirements at each point of use;
c. diversified flows for each section of the pipeline system;
d. total flow.

3.18 Guidance on deriving and calculating the above parameters is given in Chapters 4 and 5.

## Safety

3.19 Although dental air and vacuum systems are not life support systems like medical oxygen and medical air, it would be extremely inconvenient for an interruption to the supply to occur during a procedure.

3.20 Therefore, the safety of the dental air and vacuum systems is dependent on four parameters, as for medical gas pipeline systems:

a. identity;
b. adequacy;
c. continuity;
d. quality of supply.

3.21 Identity is assured by the uses of gas-specific connections throughout the pipeline system where an MGPS is installed; where dental air and vacuum systems only are installed, identity is checked during commissioning, when any cross-connection will become readily apparent.

3.22 Adequacy of supply depends on an accurate assessment of the likely demands on the system and the selection of plant appropriate to the clinical need; this is particularly important when additional dental chairs are installed, and the advice of the competent person (dental) or the authorised person (MGPS) as appropriate should be obtained.

3.23 Continuity of supply is achieved by the specification of a system which has duplicate components. This may not be considered essential for a single surgery installation, but maintenance in accordance with the manufacturers' recommendations should be carried out in order to minimise costly and inconvenient disruptions due to plant malfunction.

3.24 Quality of supply is achieved by the specification of appropriate dryers and filtration systems for the dental air and by maintenance of cleanliness throughout the installation, together with the implementation of the validation and verification procedures as set out in SHTM 2022 Part 1, 'Design, installation, validation and verification'.

## Installation

3.25 The installation of dental air and vacuum systems should be carried out only by firms registered to BS 5750 or ISO 9000 and the appropriate quality assurance scheme.

**NOTE:** The Quality Assurance Scheme 37201/206.1A for MGPS is currently under review and will be revised to include dental installations and maintenance of both MGPS and dental systems. In the meantime, all firms wishing to install dental systems should be registered to BS 5750 or ISO 9000 or have applied for such registration.

3.26 All new plant should be marked with the appropriate CE mark; plant which is not so marked should not be installed.

## Modifications

3.27 Special precautions are required when existing installations are to be modified or extended, to ensure that the sections of the pipeline systems remaining in use are not contaminated or the supply compromised by (for example) cross-connection. This is particularly important when MGPSs are installed in the same room as the dental systems.

3.28 Any work involving alteration or extension of, or maintenance to, dental systems in the vicinity of MGPS should be subject to the permit-to-work procedure as set out in SHTM 2022 Part 2, 'Operational management', and will be the responsibility of the Authorised Person (MGPS).

3.29 Where dental air and vacuum systems only are installed, the competent person (dental) should ensure that a simplified permit-to-work procedure is followed as set out in paragraphs 2.16–2.24. This is to protect the integrity of the systems. Records of all maintenance action should be retained; this is a requirement of the 'Pressure Systems Safety Regulations 2000'.

3.30 The operational policy should clearly state the arrangements for modifications and maintenance work on the dental systems.

## Fire precautions

### General

3.31 The siting and general structural principles for the design of plantrooms are given in Chapter 17 of SHTM 2022 Part 1, 'Design installation, validation and verification'; this guidance should be followed as far as reasonably practicable.

## Fire detection systems

3.32 Smoke alarms or rate of change of heat detectors should be installed in the plantrooms in any health building or practice having a fire detection system, in accordance with NHS in Scotland Firecode.

# 4. Water supplies to dental installations and effluent discharge

## General

4.1 The supply of water in Scotland is covered by The Water (Scotland) Act 1980.

4.2 This sets down the responsibilities and penalties placed on the Water authorities. The Sewage (Scotland) Act 1968 permits the Water Authority to have power in relation to effluent discharges.

## Water Authority Byelaws

4.3 The Water Authority Byelaws are concerned with the installation and maintenance of water service systems to prevent contamination of water supplies and to prevent waste, misuse and undue consumption.

4.4 New guidance has been produced by the Water Byelaws Scheme, Technical Committee for Dental Surgeries.

4.5 The main issues concerning installation in dental surgeries and departments relate to back-flow, cross-connection, permeations, or to the use of unsuitable materials.

4.6 In the treatment of patients, water is used in a variety of ways other than for domestic purposes, and is classified for these purposes as Quality Non-Domestic Water. Under this classification, it is proposed that the supply must be provided from a protected cistern, for example:

- water supplied by gravity from a cistern constructed to the requirement of BS 7181;
- water supplied via a boosted system from a cistern provided with a type A air gap complying with BS 6281 and incorporating screened weirs and warning pipes.

4.7 Under this proposed scheme, water supplied to vacuum equipment, dental chairs and automatic X-ray processing equipment is regarded as being of risk category 1, that is, where back-flow of the fluid is, or is likely to be, harmful to health from a substance continuously or frequently present.

## New installations

4.8 Equipment requiring a permanent water supply should be investigated to establish the operational flow and pressure requirements and for the inclusion of “point-of-use protection”.

4.9 In multi-occupied premises it is a requirement of the Byelaws that in addition to point-of-use protection, surgeries should be supplied by means of a separate dedicated branch supply and be provided with additional class 2 protection, as defined in the Water Byelaws, at the point of entry to the surgery.

## Existing installations

4.10 For any existing installation it is essential to carry out a review of the system to establish the extent of any remedial action required.

## Materials

4.11 Acceptable materials and fittings are listed in the WRc Water Fittings and Materials Directory.

## Effluent discharge

4.12 All gravity drainage from spittoons etc should discharge into the foul drain via a tun-dish and full depth trap.

4.13 Discharge from separators should similarly be taken to a full-depth S-trap connected to the foul drain.

**NOTE:** Recovery of the mercury amalgam should be incorporated into all new dental facilities either as part of the dental chair equipment or as a stand alone, central or local, unit.

Mercury and its compounds are included in the List 1 Substance Directive 76/464/EEC and is listed in the Government “Red List“ and EC “Black List“ of chemicals.

# 5. Dental air

## General principles

5.1 Dental air is used as the power source for dental instruments which require a slightly higher pressure than ventilators. It is also required in dental laboratories, for example for sand-blasting equipment.

5.2 Very few dental chairs are now operated by compressed air. If the dental chair is operated by compressed air, a separate compressor may be required. The dental air should not be used.

5.3 Dental air systems should not be used to operate pneumatic controls (other than for the dental chair and associated equipment) or for any purpose other than clinical and laboratory dental procedures.

## Performance requirements

5.4 The power unit for the dental instruments requires a supply of air at between 550 and 700 kPa and a flow of 35–70 litres/minute. This may vary depending on the equipment specified, and therefore this should be checked with the equipment manufacturer.

5.5 The instruments normally operate at about 420 kPa, but a higher pressure is required to allow for the pressure loss across the regulator. A consumption of 55 litres/minute at 400 kPa is typical for the instruments.

## Plant sizing

5.6 In order to ensure that a minimum of 55 litres/minute is available at each operating point, the dental air system should be designed to provide a minimum of 70 litres/minute at 550 kPa at each dental chair to allow for losses across the regulator.

5.7 For a single surgery, this would result in a compressor with a free air displacement of 70–80 litres/minute at 600 kPa for a nominal 500 kPa system. For two surgeries this would result in a compressor with a displacement of 140 litres/minute.

5.8 For surgeries with up to three dental chairs, it can be assumed that all three chairs may be in use simultaneously. For surgeries with more than three dental chairs, it can be assumed that 60% of the remainder of the chairs will be using compressed air simultaneously.

5.9 The total system demand will be as follows:

$$Q = (3 \times 70) + (n - 3) \times 0.6 \times 70 \text{ litres/minute}$$

where n = number of dental chairs.

5.10 For example, for a dental department with 20 dental chairs, the system demand would be:

$$Q = 210 + 17 \times 0.6 \times 70 = 926 \text{ litres/minute.}$$

## Pipeline design

5.11 The pipeline should be designed to produce a minimum of 5.5 bar at each dental chair under total system demand flow conditions, as calculated above, taking into account the diversity, calculated above.

5.12 For plant operating at a nominal delivery pressure of 600 kPa, the pipeline system should be designed on the basis of a pressure loss of 0.5 bar between the plant and the dental chair.

5.13 The pressure losses in Figure 1 can be used to calculate the pipeline sizes.

## Pipeline materials

5.14 The pipeline system can be of either copper in accordance with SHTM 2022 Part 1, ‘Design. installation, validation and verification’, or nylon such as Tecalon. For larger installations, that is, more than 2/3 dental chairs, copper is preferred. The copper pipelines should be installed in accordance with the installations guidance given in SHTM 2022.

5.15 If nylon pipes are used, care must be taken to ensure that fire safety is not compromised.

5.16 Where dental compressed air is installed with medical gas pipeline systems, the validation and verification procedures as set out in SHTM 2022 Part 1, ‘Design, installation, validation and verification’ should be followed.

5.17 Where work is to be carried out on an existing dental system, the permit-to-work should be followed as set out in SHTM 2022 Part 2, ‘Operational management’; the parts which do not apply should be clearly marked “not applicable”.

## Compressor systems

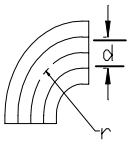
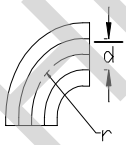
5.18 In order to achieve the quality specification set out in Table 1, it will be necessary for a dryer system to be incorporated into the plant as well as appropriate filtration. The major components of a dental air system are shown in Figure 2.

## Siting

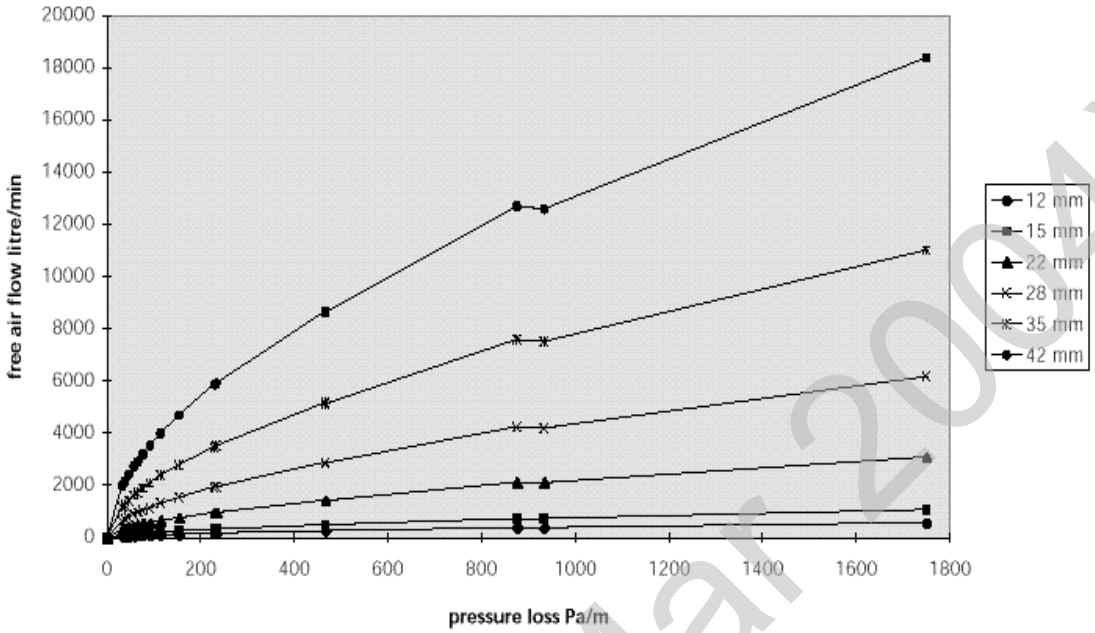
5.19 The plant should have all-round access for maintenance purposes, and allowance should be made for changing major components.

5.20 Air inlet filters should be fitted immediately upstream of the compressor. In exceptional circumstances additional screens, filters and silencers may be required.

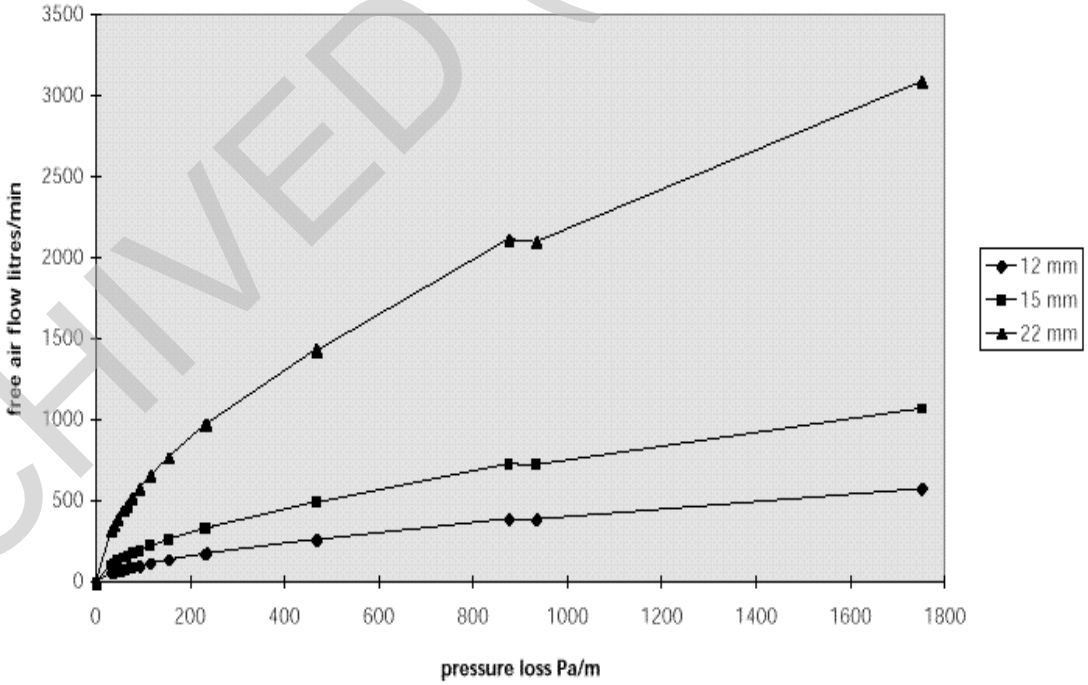
**Figure 1: Pipeline pressure loss**

| Pipe diameter (mm) | Fittings – equivalent length (m) | | | |
|---|---|---|---|---|
| | 6 | 8 | 10 | 12 |
| r ≥ 2 x d Elbow  | 0.08 | 0.10 | 0.12 | 0.15 |
| Tee  | 0.12 | 0.15 | 0.18 | 0.21 |
| r ≥ d Angle  | 0.17 | 0.20 | 0.25 | 0.30 |
| 90° fittings  | 0.46 | 0.50 | 0.70 | 0.80 |

## Pressure loss data for 600 kPa systems




## Pressure loss data for 12, 15 and 22 mm dia pipes for 600 kPa systems



5.21 The air filters should comply with BS 7226:1989 and be either medium filters or grade CA paper element filters.

5.22 The compressor and drier plant should ideally be installed in a dust-free, dry, cool room. The room should be well ventilated as shown in Figure 3.

5.23 The optimum temperature range is 10-15°C; additional forced ventilation will be required if the ambient temperature exceeds 35°C.

5.24 An air compressor gives off approximately 70% of its generated power as heat energy; a compressor system designed to develop 500 litres/minute at 5 bar generates approximately 3 kW. This will need to be taken into account when considering the room ventilation.

5.25 The performance of the compressor and dryer is seriously impaired if the ambient temperature rises above 35°C; the temperature must not fall below +5°C to prevent condensation forming and the control mechanism and the dryer system freezing.

## Noise

5.26 The noise level of the system will obviously increase with the capacity of the supply systems. The maximum free field noise level at 1m distance for unsilenced compressed air plant varies with the type and power of the plant. Typical noise levels are given in Table 2.

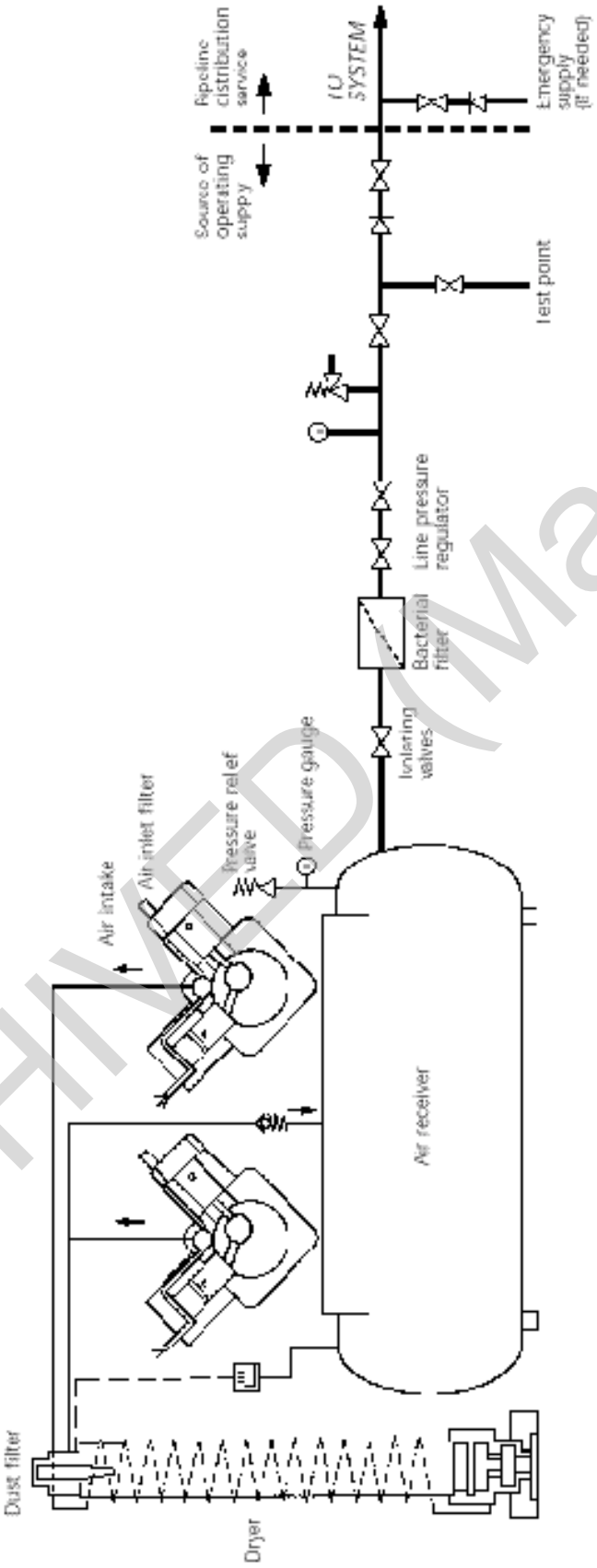
**Table 2: Compressor plant noise levels**

| Power (kW) | Maximum free field noise level at 1m – unsilenced plant (dBA) | Maximum free field noise level at 1m – silenced plant or in acoustic cabinet (dBA) |
|---|---|---|
| 1.5 | 67.5 | 58 |
| 1.8 | 73.5 | 59 |
| 2 x 1.5 | 75 | |
| 2 x 2.2 | 80 | |

## Air intake

5.27 The air intake for the compressor plant should be located to minimise contamination from internal combustion engine exhausts and the discharge from vacuum systems, anaesthetic gas scavenging systems and ventilation systems or other potential sources of contamination.

**Figure 2: Dental air system**



## Compressor lubrication

5.28 Oil-free compressors have been used successfully in dental surgeries, and obviate the need for oil separators and filters. Care should, however, be taken to ensure that PTFE rings and lubricating oils do not become excessively hot. A temperature sensor may be fitted with suitable controls to cut off the power supply in the event of excessive temperature.

## Air treatment

5.29 Contaminants can enter the compressed air systems from three sources: the atmosphere, the compressor, and the pipeline distribution system. Each potential source must be taken into account when specifying the type and location of air treatment equipment.

5.30 A 5 micron air intake filter is required to prevent blockage of internal air/oil separators.

5.31 Water is always a contaminant in a compressed air system, regardless of the type and location of the compressor plant, since the air drawn into the compressor intake is never completely free of water vapour.

5.32 The receiver should be coated internally to minimise rust production.

5.33 A water content not to exceed a dew-point of -20°C at atmospheric pressure is recommended in order to avoid these problems.

5.34 This may be difficult to achieve in practice with a refrigerant dryer, and therefore desiccant dryer should be used.

**NOTE:** A refrigerant dryer may be appropriate in small installations, that is, fewer than 2/3 chairs, provided that the length of external pipework is negligible.

5.35 The dryer can be located either upstream or downstream of the air receiver depending upon the design of the system.

5.36 For small installations, there may be advantages in locating the dryer upstream of the receiver in order to ensure that the air receiver is not contaminated with moist air and that the dry air from the receiver can be used to regenerate the dryer.

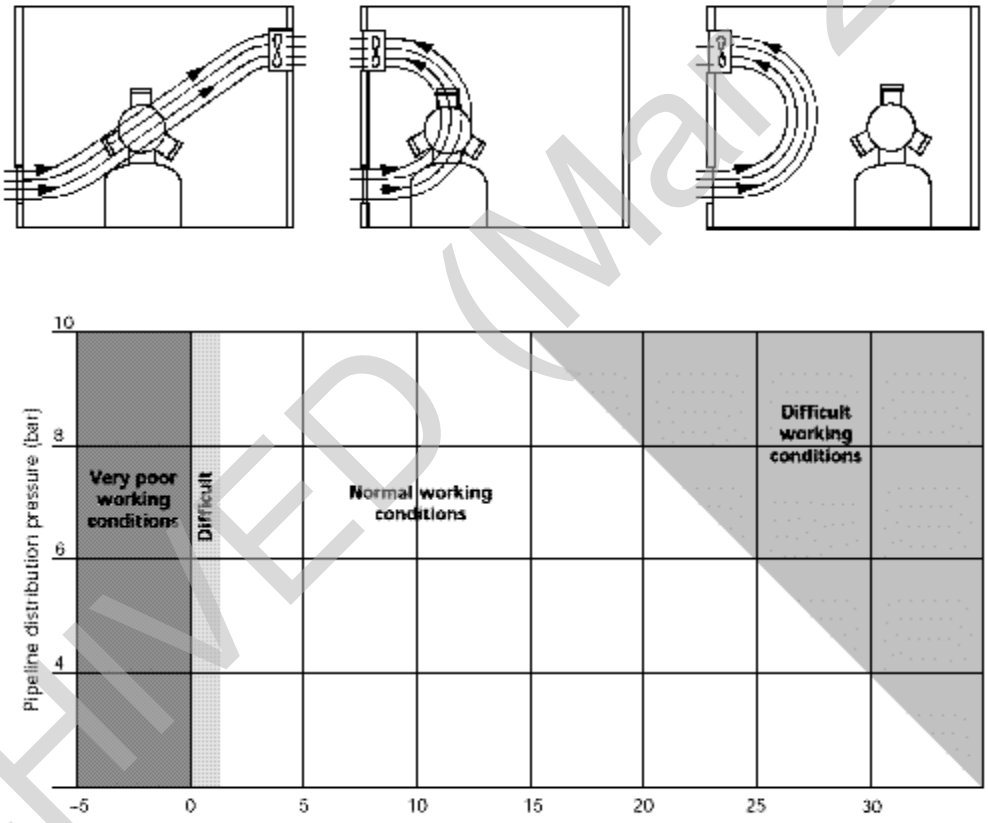
5.37 If the dryer is located downstream of the receiver, the receiver acts as a secondary after-cooler and also smoothes out the pulsing effect of a reciprocating pump. This may be appropriate to larger installations.

5.38 The dryer system should be fitted with a hygrometer to continuously monitor the dryness of the compressed air and automatically shut down the system in the event of excessive moisture.

5.39 An alarm should be installed to indicate high moisture content. For the smaller system it may be more appropriate to alarm this condition rather than automatically shutting down the system, which may be inconvenient. The dew-point may rise to a pressure dew-point of +3°C before the system should alarm. Details of alarms are given in paragraphs 5.47-5.49.

5.40 A typical system with the dryer located upstream of the receiver is shown in Figure 2.

**Figure 3: Plant ventilation**




5.41 A duplex dryer system would not normally be required for dental surgeries, although it would be considered for a dental school or large department where downtime for maintenance would cause unacceptable disruption.

**NOTE:** For dental schools and other large installations, the guidance given in SHTM 2022 should be followed where MGPSs are installed in addition to dental air and vacuum systems.

## Filters

5.42 There should be a dust filter downstream of the dryers to remove particles down to 1 micron with a DOP penetration of less than 0.03% when tested in accordance with BS 3928.

5.43 Each dryer and filter assembly should be rated for continuous use at the system demand flow with air at 80% relative humidity at 35°C.

5.44 A bacterial filter should be fitted downstream of the plant, with appropriate isolating valves. The filters should provide particle removal to 0.01 $mg/m^3$ and a DOP penetration of less than 0.0001%.

5.45 For large installations where oil-lubricated compressors are installed, pre-filter, oil coalescing and activated charcoal filters will also be required. The guidance given in SHTM 2022 for medical air systems should be followed for these filters.

## Safety valves

5.46 Safety valves should be provided in accordance with the system requirements. All valves should conform to BS 6759: Part 2: 1984 or equivalent. They should be provided in accordance with SHTM 2022 Part 2, 'Design, installation, verification and validation'.

## Operating and indicating system

5.47 The following conditions should be monitored and alarmed:

plant monitoring:

a. plant fault:
   (i) compressor unit – failure to start;
   (ii) dryer unit – dryer failure; dew-point above -20°C at atmospheric pressure;

plant alarm:

a. green – normal;
b. yellow – plant fault;
c. red – system failure (pressure fault).

5.48 The following conditions should be transmitted to the dental surgery:

a. system normal – the compressor system and dryer is fully operational;
b. system faulty – plant fault;
c. system emergency – plant failure.

5.49 A simplified operating and indicating system may be more appropriate for small systems, and should provide running and fault conditions in the dental surgery.

## Emergency supplies

5.50 In clinics or departments where the sudden loss or interruption to the dental compressed air system would compromise patient safety, a cylinder of medical compressed air, complete with regulator, should be available.

5.51 In small surgeries this may not be justifiable, as the possible consequences of such an interruption to the supply are insignificant. The chief executive or senior partner or principal should carry out a risk assessment to ensure that appropriate emergency provision is available.

5.52 For large systems, consideration should be given to the provision of an emergency inlet for connection to an emergency supply.

# 6. Dental vacuum systems

## Rationale

6.1 Many attempts have been made to revise BS 5185: 1975, which is withdrawn. Much of the deliberations concerned the design and relative merits of wet and dry vacuum systems.

6.2 This document gives guidance on dry systems because it is considered overall that such systems offer greater safety, simplicity and cost-effectiveness in operation.

6.3 The committee which was convened to prepare a revised BS was unable to reach a consensus and therefore a revised BS was never published.

6.4 Guidance is, however, required covering the general operating principles and safety requirements of dental vacuum systems for modern surgeries.

## General principles

6.5 The guidance given in this document is for dry systems in which separation of dental detritus, sputa and cooling water from high-speed drills and instruments takes place at the point of use and is discharged to drain.

6.6 The vacuum line is therefore relatively dry and clean compared with a wet system. This is important in order to minimise bacterial contamination of the vacuum line, which could otherwise present a safety hazard when maintenance work is carried out.

6.7 There should be an operational policy covering all work on vacuum lines to ensure that the system is properly decontaminated prior to work on the system, for example breaking into an existing system. The advice of the local control of infection officer should be sought.

6.8 With the advent of high-speed instruments, the cooling water volume is increased beyond the performance capabilities of venturi-type saliva extractors. A fine water aerosol mist is formed by the cooling jet hitting the working ends moving at high speed. This not only results in poor visibility in the vicinity of the operation site, but is also an ideal carrier of micro-organisms.

6.9 A high-flow, low-suction system, together with a specially designed cannula, is therefore required in order to provide a safe and convenient operation site.

6.10 The suction system comprises the following components:

a. suction hoses for spray mist cannula and saliva hose;

b. automatic separator to separate air from secretion and dirt particles;

c. vacuum pipeline system and plant.

6.11 The system is designed to aspirate air, saliva, blood, amalgam and other materials and dust from tooth tissue. A specifically designed cannula with typically 1 $cm^2$ cross-section with an air speed of typically 50 m/sec has been shown to be effective.

6.12 The particles are aspirated through the suction hose, typically of 22 mm diameter, at a typical air speed of 15–20 m/s into the automatic separator which is located adjacent to the workplace, usually built in to the workstation.

6.13 Larger particles, that is, >1 mm, are filtered out upstream from the air separator. The air separator separates the residual particles, including water.

6.14 A diagram of a typical suction system is shown in Figure 4.

## Maintenance

6.15 The system will require routine maintenance in accordance with the manufacturer's instructions to ensure satisfactory operation and to prevent organic material and moisture from being drawn into the vacuum pipeline system.

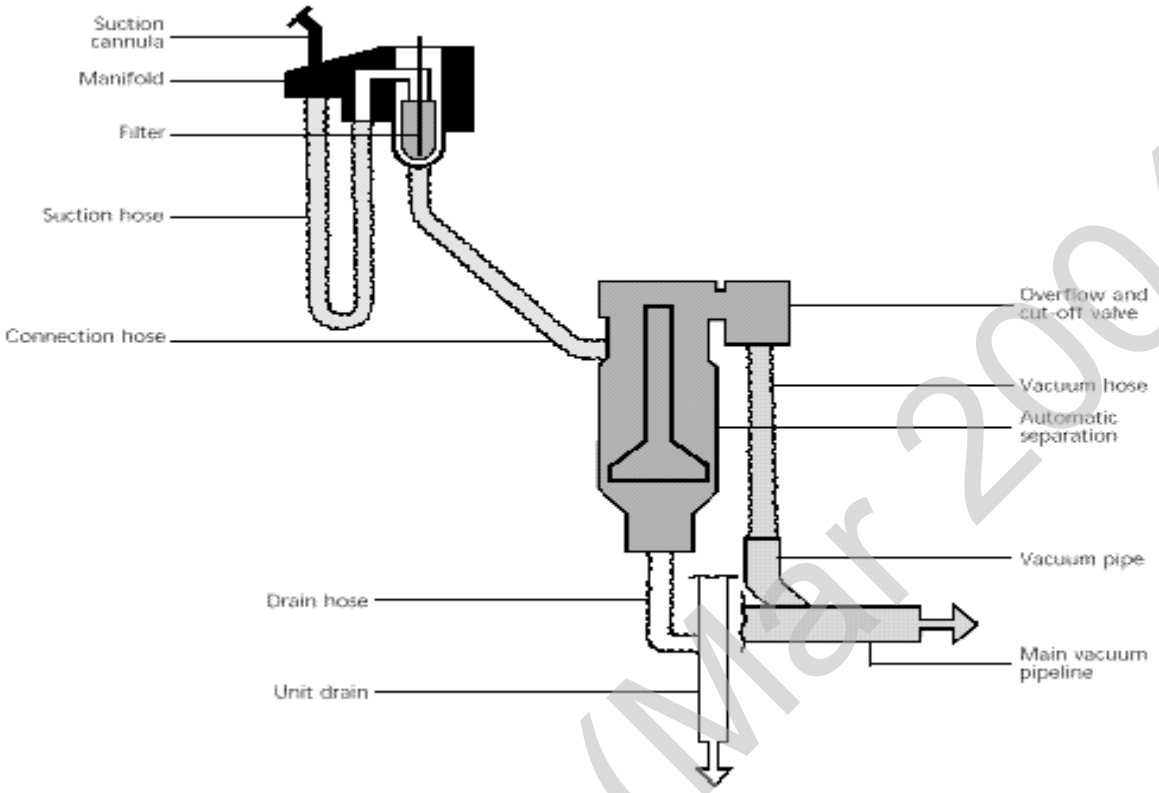
6.16 A typical procedure would be:

a. after procedures involving blood, a glass of cold water should be aspirated through the hose or hoses used;

b. daily, a suitable cleaning and disinfecting agent should be aspirated through the system.

6.17 The disinfecting agent is aspirated into the automatic separator to ensure that the separator is clean. The filter element will need to be changed one or twice per week, depending on use, in accordance with the manufacturer's instructions.

**Figure 4: Typical suction system at the chair**




## Performance requirements

6.18 A flow rate of approximately 350 litres/minute at a suction pressure of 75 mm Hg is required at each suction unit at the dental chair.

6.19 The entry velocity into the suction cannula is approximately 50 m/s, which is reduced to about 10–20 m/s in the suction hose; this is to ensure a satisfactory transfer of particulate matter. A filter upstream of the separator removes particles larger than 1 mm and the air separator removes smaller particles.

6.20 Relatively clean, dry air is therefore drawn into the vacuum system.

## Vacuum pipeline system design

6.21 In order to ensure efficient operation, a flow rate of 300–350 litres/minute is required at each aspiration point.

6.22 The system performance should be based on a flow of 300 litres/minute at each workplace.

6.23 For surgeries with up to three dental chairs, it can be assumed that all the chairs may be in use simultaneously, and therefore no diversity should be allowed.

6.24 For systems with more than three dental chairs, it may be assumed that 60% of the remainder of the chairs will be in use simultaneously.

6.25 The total system demand therefore will be:

$Q_{vac} = 3 \times 300 + (n - 3) \times 0.6 \times 300$ litres/minute

**NOTE:** Although vacuum may be used almost continuously throughout treatment (unlike compressed air which is used intermittently), there will be periods of downtime between patients etc. The diversity is derived from the assumption that the vacuum is used for 40 minutes in any one hour, that is, 60% of the time.

6.26 The system should be designed to allow a pressure loss of a maximum of 45 mm Hg for large systems (>7000 litres/minute) and 25 mm Hg for smaller systems between the plant and the equipment.

6.27 The pipeline sizes can be calculated from Figure 5.

## Vacuum pipeline materials

6.28 The pipelines are only clean between the vacuum plant and the separators. The maximum vacuum is -0.25 bar (approx. -190 mm Hg).

6.29 The choice of material is governed by:

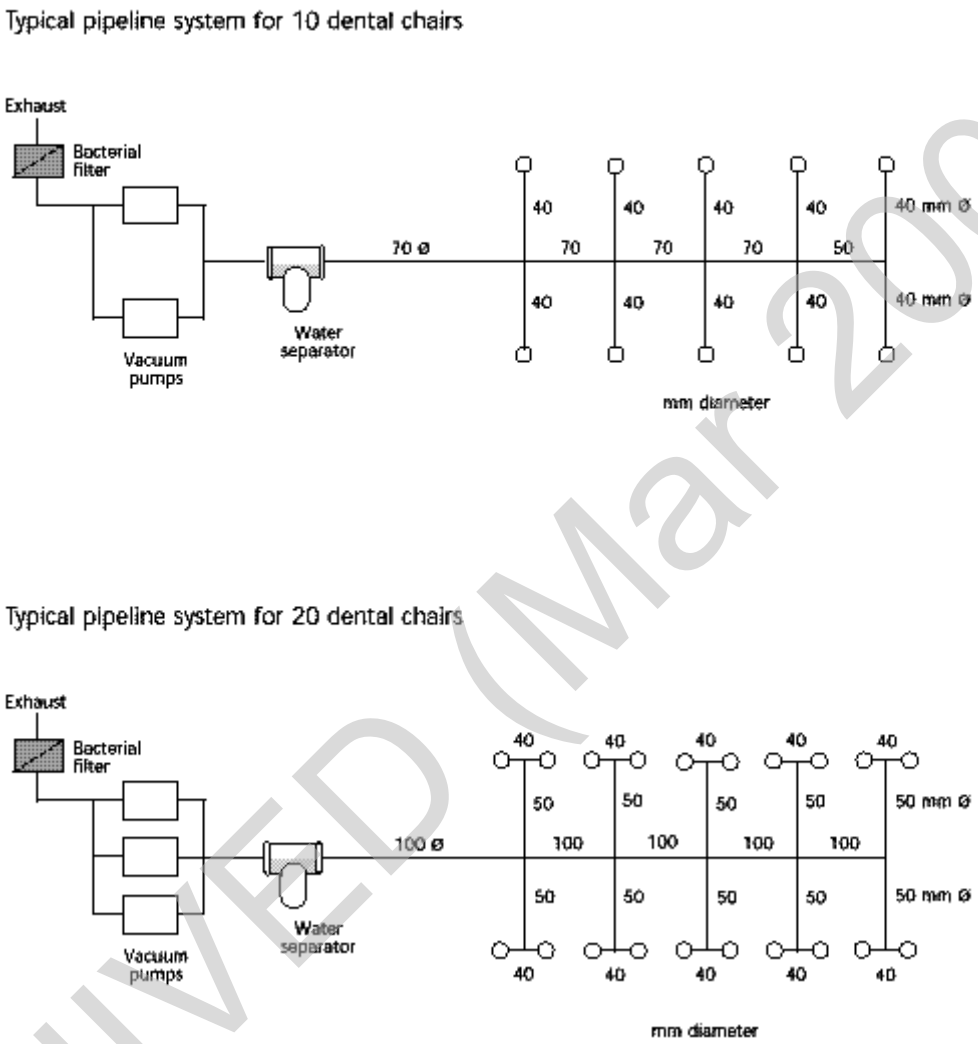
a. the requirement that the material must withstand -0.25 bar (approx -190 mm Hg);
b. fire safety;
c. cost.

6.30 The vacuum and exhaust lines can be either copper – as medical vacuum lines, see SHTM 2022 Part 1, 'Design, installation, validation and verification' – or polythene and polypropylene or uPVC.

6.31 Where non-metallic pipelines pass through fire compartmental walls/barriers they should be suitably sleeved.

6.32 Pipes made from ABS /ASA material are not suitable for use with the medications and solutions used in dental systems.

**Figure 5: Vacuum system pipeline sizing**




## Plant location

6.33 The plant should have all-round access for maintenance purposes and allowance should be made for changing major components. Plant layout diagrams should be provided, particularly for duplex systems.

6.34 The vacuum pumps generate approximately 30% of the electrical load as heat input into the room; this should be taken into account when designing the plantroom. Extract ventilation may be required to prevent the ambient temperature rising above 30°C.

## Dental vacuum plant exhaust

6.35 The exhaust pipe from the vacuum system must be sited outside at roof level away from air intakes, opening windows etc. It should be clearly labelled “Dental vacuum discharge point – do not obstruct”.

6.36 The exhaust pipe should turn down to prevent influx of rainwater and have a mesh to protect against ingress of insects, vermin, birds etc.

6.37 The exhaust pipe should be provided with a drain valve at its lowest point.

6.38 Noise from the exhaust should be considered and a silencer fitted if required.

6.39 The exhaust from a duplex (or triplex) system may be manifolded together to one external exhaust.

6.40 The vacuum pumps should be sized to take into account the back-pressure of the exhaust system and the resistance of the bacterial filter.

## Bacterial filter

6.41 A bacterial filter should be fitted on the suction side of the pump with appropriate isolating valves. The filters should provide particle removal to 0.01 mg/m$^3$ and a DOP penetration of less than 0.0001%.

6.42 The bacterial filter should be marked with the legend **“bio-hazard”** together with a description of a safe procedure for changing and disposing of the filters and emptying the drainage trap.

6.43 These filters will require to be changed approximately every two years. The procedure in SHTM 2022 Part 2, ‘Operational management’ should be followed.

6.44 Micro-organisms can penetrate a bacterial filter if the material becomes wet. It is essential that the dryness of the dental air supplied to a bacterial filter is checked regularly – preferably with an in-line monitor – to ensure that the filter does not become wet.

## Condensate water separator

6.45 In order to avoid considerable water condensation due to large temperature differences, it is advisable not to install the vacuum lines close to outside walls.

6.46 All vacuum lines should be provided with a condensation water separator.

6.47 This should be installed as close as possible to the vacuum plant and at the lowest point of the vacuum line.

6.48 The separator should be easily accessible and preferably fitted with an automatic drain.

6.49 The pressure loss caused by the water separator should not exceed 1.5 mm Hg under maximum flow conditions.

## Plant monitoring and alarm systems

6.50 A plant monitoring and alarm system should be installed similar to that for the dental compressed air system.

6.51 A simplified system (see dental compressed air systems, paragraphs 5.47–5.49) may be more appropriate for small systems.

# 7. Accommodation for dental compressors and vacuum pumps

## Notices

7.1 Smoking, welding and naked lights should be prohibited within or near the plantroom, and notices should be provided both within and outside the room to indicate this.

7.2 In addition, a notice clearly indicating the content of the room should be displayed on the access door.

## General

7.3 Guidance on accommodation for medical gas cylinders (main stores and ready use stores) and for manifolds, compressors, vacuum pumps and PSA plants (that is, plantrooms) is given in SHTM 2022 Part 1, 'Design, installation, validation and verification'. The general principles should be followed for dental compressors and vacuum plant. These include a number of basic design guidelines covering the following:

a. ventilation. All plant accommodation should be well ventilated;

b. labelling. All plant accommodation should be clearly labelled as to its purpose. Details of emergency action procedures and location of keys should be posted, as should no smoking and other warning signs;

c. access. Clear and secure access to all plant accommodation is required, taking into account requirements for maintenance and plant replacement;

d. fire protection. All plant accommodation should be free from naked flames and all sources of ignition, and should be designated as "no smoking" areas.

7.4 Appropriate fire extinguishing equipment should be readily available.

7.5 Lightning protection may be necessary for isolated buildings, and BS 6651 should be consulted.

## Design and construction of plantrooms

### Location of plantrooms

7.6 Cylinder gas/liquid supply systems should not be located in the same room as medical or dental air compressors, or vacuum plants.

### Access

7.7 Access to plantrooms should be preferably from the open air, not from corridors or other rooms.

## Heating and ventilation of plantrooms

7.8 Ventilation louvres should be provided at both high and low levels for all plantrooms to allow circulation of air. As a guide, well separated openings equivalent to at least 1.5% of the total area of the walls and room should be provided. For example, given a plantroom 5 × 4 × 2.4 m with a total area of walls and ceiling of 63.2 $m^2$, the TOTAL free open area for ventilation required is 1 $m^2$.

7.9 The aspirated air inlets should, if possible, be located externally, and should vent to a safe area away from ventilation plant intakes etc. However, they should not be taken as an alternative to the provision of an adequate air supply for cooling purposes.

7.10 All vents should be vermin/bird proof.

7.11 Air compressors liberate, under maximum flow conditions, considerable heat. Moreover, these plants aspirate air for breathing purposes. Generous natural ventilation should be provided. The ambient temperature of manifold rooms and plantrooms should be maintained within the range of 10°C to 40°C. The ventilation rates should ensure that the plantroom temperature does not exceed ambient temperature by more than 10°C.

7.12 In some cases it may be necessary to provide mechanical ventilation for plantrooms, with supply air directed towards the compressor air intakes and inter/aftercoolers. It should rarely be necessary to provide cooling.

## Lighting

7.13 Manifold rooms should be provided with lighting to an illumination level of 150 lux (15 lumens/sq ft) by means of bulkhead lighting fittings to IP 54 BS EN 60529: 1992. Plantrooms other than manifold rooms should be provided with a lighting level of 200 lux (20 lumens/sq ft).

## Noise control

7.14 Plantrooms should be designed and constructed to ensure the satisfactory control of noise emission. The effect of two vacuum pumps or compressors running together in the case of duplex installations and three or more in the case of multiplex installations, will be to increase the free field noise level outside the plantroom by about 5 dBA for each additional pump or compressor operation over and above the specified limits. Consideration

should be given to providing acoustic enclosures to reduce the free field noise levels in noise-sensitive areas adjacent to the plantroom.

7.15 Acoustic enclosures and/or plantroom design must not inhibit normal cooling functions or maintenance activities.

7.16 Free field noise levels should be given to the architect to assist in acoustic designing of the plantrooms.

7.17 The discharge from some vacuum pumps may require silencing, although it should be noted that rotary pump exhausts are not likely to require silencers. Compressors and pumps should be mounted on properly selected anti-vibration mountings, where necessary, to minimise transfer of noise and vibration to the structure of the building.

7.18 All pipework and electrical conduits connected to the plant should be fitted with flexible connectors where necessary to prevent the transmission of noise and vibration along the pipelines and conduits.

# 8. Electricity supply to dental air and vacuum installations

## General

8.1 The installation should comply in all respects with BS 7671, 'Requirements for Electrical Installations', IEE Wiring Regulations, 16th edition (and subsequent amendments) and SHTM 2007; *Electrical services: supply and distribution*.

8.2 Care is required when selecting pipeline routes to prevent the pipes coming into contact with electric cables and wiring and to minimise the risk of electric shock in the event of a fault on adjacent cables.

8.3 The final connection to any equipment, for example alarm panels or control panels, should be made via an unswitched fused connection unit.

## Earthing

8.4 Pipelines should be bonded to the consumer's earth terminal as required by Regulation 413-2 of the IEE Regulations. This bonding should be made as near as possible to the point at which the pipeline enters the building from the plant. The size of the bonding conductor should be in accordance with Table 54f of the Regulations. The pipelines should not themselves be used for earthing the electrical equipment.

8.5 Flexible pipeline connections between the compressors or vacuum pumping plant and the fixed pipelines should be bonded across to comply with this requirement. Flexible connections in the fixed pipelines should not normally be used, but if they are specially approved they should be similarly bonded across.

## Installation of electrical cables

8.6 Distribution of pipelines should preferably be physically separated from the metal sheath and armour of electrical cables as well as from metal conduits, ducts and trunking and bare earth-continuity conductors associated with any electric cables which operate at low voltage or above.

8.7 When physical separation is impracticable, or where there might be contact with extraneous metalwork, for example where the pipes are carried in metal partitions or where terminal units are mounted on metal bedhead units, the pipelines should be effectively bonded to the metalwork in accordance with Regulation 525-10 of the IEE Regulations.

8.8 Where piped gases and electrical wiring are enclosed in a boom, gas control panel or other similar enclosure, the wiring should be carried in separate conduit or trunking so that it cannot come into direct contact with the piped gas installation. Where this is not possible, the wiring should be secured in the most effective possible manner clear of the medical gas pipes, and the cables should comply with Regulation 523-17 of the IEE Regulations.

## Electrical wiring in plantrooms

8.9 All electrical wiring in these rooms should be carried out using MICS cable or cable of the type indicated in IEE Regulation 523-17 with adequate protection against mechanical damage.

8.10 Fire-resistant cable to BS 6899, PVC armoured cables and single insulated cables in conduit may also be used.

8.11 Each compressor, vacuum pump and manifold should be supplied from a separate sub-circuit where appropriate.

8.12 Metal-clad sockets, connection units and switches should be used in plantrooms; plastic fittings are not appropriate.

**NOTE:** Reference should be made to SHTM 2007; *Electrical Services Supply and Distribution*.

# References

**NOTE:**
*Where there is a requirement to address a listed reference, care should be taken to ensure that all amendments following the date of issue are included.*

| ***Publication ID*** | ***Title*** | ***Publisher*** | ***Date*** | ***Notes*** |
|---|---|---|---|---|
| **Acts and Regulations** | | | | |
| | The Building (Scotland) Act | HMSO | 1959 | |
| | Clean Air Act | HMSO | 1993 | |
| | Electricity Act | HMSO | 1989 | |
| | Health and Medicines Act | HMSO | 1998 | |
| | Health and Safety at Work etc Act | HMSO | 1974 | |
| | Medicines Act | HMSO | 1968 | |
| | Public Health Act | HMSO | 1961 | |
| | The Public Health (Scotland) Act | HMSO | 1897 | |
| | Registered Establishments (Scotland) Act | HMSO | 1998 | |
| | Sewage (Scotland) Act | HMSO | 1968 | |
| | The Water (Scotland) Act | HMSO | 1980 | |
| | Water Industry Act | HMSO | 1991 | |
| | Water Resources Act | HMSO | 1991 | |
| SI 2179 & 187 | The Building Standards (Scotland) Regulations (as amended) | HMSO | 1990 | |
| | The Building Standards (Scotland) Regulations: Technical Standards Guidance | HMSO | 1998 | |
| SI 1460 | Chemicals (Hazard Information and Packaging for Supply) Regulations (CHIP2) | HMSO | 1997 | |
| SI 3140 | Construction (Design and Management) Regulations | HMSO | 1994 | |
| SI 437 | Control of Substances Hazardous to Health Regulations (COSHH) | HMSO | 1999 | |
| SI 3260 | Electrical Equipment (Safety) Regulations | HMSO | 1994 | |
| SI 635 | Electricity at Work Regulations | HMSO | 1989 | |
| SI 1057 | Electricity Supply Regulations (as amended) | HMSO | 1988 (amd 1994) | |

| Publication ID | Title | Publisher | Date | Notes |
|---|---|---|---|---|
| SI 2372 | Electromagnetic Compatibility Regulations (as amended) | HMSO | 1992 | |
| SI 2451 | Gas Safety (Installation and Use) Regulations | HMSO | 1998 | |
| SI 917 | Health & Safety (First Aid) Regulations | HMSO | 1981 | |
| SI 682 | Health & Safety (Information for Employees) Regulations | HMSO | 1989 | |
| SI 2792 | Health and Safety (Display Screen Equipment) Regulation | HMSO | 1992 | |
| SI 341 | Health and Safety (Safety Signs and Signals) Regulations | HMSO | 1996 | |
| SI 1380 | Health and Safety (Training for Employment) Regulations | HMSO | 1990 | |
| SI 917 | Highly Flammable Liquids and Liquefied Petroleum Gases Regulations | HMSO | 1972 | |
| SI 2307 | Lifting Operations and Lifting Equipment Regulations (LOLER) | HMSO | 1998 | |
| SI 3242 | Management of Health and Safety at Work Regulations | HMSO | 1999 | |
| SI 2793 | Manual Handling Operations Regulations | HMSO | 1992 | |
| SI 1790 | Noise at Work Regulations | HMSO | 1989 | |
| SI 3139 | Personal Protective Equipment (EC Directive) Regulations (as amended) | HMSO | 1992 | |
| SI 2966 | Personal Protective Equipment at Work (PPE) Regulations | HMSO | 1992 | |
| SI 128 | Pressure Systems Safety Regulations (PSSR) | HMSO | 2000 | |
| SI 2306 | Provision and Use of Work Equipment Regulations (PUWER) | HMSO | 1998 | |
| SI 3163 | Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR) | HMSO | 1995 | |
| SI 3004 | Workplace (Health, Safety and Welfare) Regulations | HMSO | 1992 | |
| **British Standards** | | | | |
| BS 88 | **Cartridge fuses, for voltages up to and including 1000 V a.c. and 1500 V d.c.** **Part 2.2:** Specification for fuses for use by authorised persons (mainly for industrial application). Additional requirements for fuses with fuse-links for bolted connections. | BSI Standards | 1988 | |

| *Publication ID* | *Title* | *Publisher* | *Date* | *Notes* |
|---|---|---|---|---|
| BS 89 | **Direct acting indicating analogue electrical measuring instruments and their accessories.** **Part 2:** Specificaton for special requirements for ammeters and voltmeters | BSI Standards | 1990 | |
| BS 341 | **Transportable gas containers valves** | BSI Standards | 1962/ 1991 | |
| BS 476-4 | **Fire tests on building materials and structures. Non-combustibility test for materials** | BSI Standards | 1970 | |
| BS 1710 | **Specification for identification of pipelines and services** | BSI Standards | 1984 | |
| BS 2099 | **Specification for castors for hospital equipment** | BSI Standards | 1989 | |
| BS 2718 | **Specification for gas cylinder trolleys** | BSI Standards | 1979 | |
| BS 3928 | **Method for sodium flame test for air filters (other than for air supply to I/C engines and compressors)** | BSI Standards | 1969 | |
| BS 4272 | **Anaesthetic and analgesic machines** **Part 3:** Specification for continuous flow anaesthetic machines | BSI Standards | 1989 | |
| BS 4322 | **Recommendations for buffering on hospital vehicles such as trolleys** | BSI Standards | 1968 | |
| BS 5045 | **Transportable gas containers** **All Parts** | BSI Standards | | |
| BS 5169 | **Specification for fusion welded steel air receivers** | BSI Standards | 1992 | |
| BS 5378 | **Safety signs and colours** | BSI Standards | 1980 | |
| BS 5499 | **Fire safety signs and graphic symbols** | BSI Standards | 1990 | |
| BS 5682 | **Specification for probes (quick connectors) for use with medical gas pipeline systems** | BSI Standards | 1998 | |

| *Publication ID* | *Title* | *Publisher* | *Date* | *Notes* |
|---|---|---|---|---|
| BS 5724 | **Medical electrical equipment**<br>**Part 1:** General requirements for safety<br>**Part 2:** Particular requirements for safety<br>**Section 2.12:** Specification for lung ventilators<br>**Section 2.13:** Specification for anaesthetic machines | BSI Standards | 1990 | |
| BS 6281 | **Devices without moving parts for the prevention of contamination of water by backflow** | BSI Standards | 1992 | |
| BS 6387 | **Specification for performance requirements for cables required to maintain circuit integrity under fire conditions** | BSI Standards | 1994 | |
| BS 6651 | **Code of practice for protection of structures against lightning** | BSI Standards | 1999 | |
| BS 6759 | **Safety valves**<br>**Part 2:** Specification for safety valves for compressed air or inert gases | BSI Standards | 1984 | |
| BS 7181 | **Specification for storage cisterns up to 500l actual capacity for water supply for domestic purposes** | BSI Standards | 1989 | |
| BS 7671 | **Requirements for electrical installations. IEE Wiring regulations sixteenth edition** | BSI Standards | 2001 | |
| BS EN 132 | **Respiratory protective devices. Definitions of terms and pictograms** | BSI Standards | 1999 | |
| BS EN 740 | **Anaesthetic workstations and their modules. Particular requirements** | BSI Standards | 1999 | |
| BS EN 737-1 | **Medical gas pipeline systems. Terminal units for compressed medical gases and vacuum** | BSI Standards | 1998 | |
| BS EN 737-2 | **Medical gas pipeline systems. Anaesthetic gas scavenging disposal systems. Basic requirements** | BSI Standards | 1998 | |
| BS EN 737-3 | **Medical gas pipeline systems. Pipelines for compressed medical gases and vacuum** | BSI Standards | 2000 | |

| *Publication ID* | *Title* | *Publisher* | *Date* | *Notes* |
|---|---|---|---|---|
| BS EN 737-4 | **Medical gas pipeline systems. Terminal units for anaesthetic gas scavenging systems** | BSI Standards | 1998 | |
| BS EN 837-1 | **Pressure gauges. Bourdon tube pressure gauges. Dimensions, metrology, requirements and testing** | BSI Standards | 1998 | |
| BS EN 837-2 | **Pressure gauges. Selection and installation recommendations for pressure gauges** | BSI Standards | 1998 | |
| BS EN 837-3 | **Pressure gauges. Diaphragm and capsule pressure gauges. Dimensions, metrology, requirements and testing** | BSI Standards | 1998 | |
| BS EN 850 | **Transportable gas cylinders. Pin-index, yoke-type valve outlet connections for medical use** | BSI Standards | 1997 | |
| BS EN 1044 | **Brazing. Filler metals** | BSI Standards | 1999 | |
| BS EN 1057 | **Copper and copper alloys. Seamless, round copper tubes for water and gas in sanitary and heating applications** | BSI Standards | 1996 | |
| BS EN 1089-3 | **Transportable gas cylinders. Gas cylinder identification (excluding LPG). Colour coding** | BSI Standards | 1997 | |
| BS EN 1251-3 | **Cryogenic vessels – transportable vacuum insulated vessels of not more than 1000 litres volume – operational requirements** | BSI Standards | 2000 | |
| BS EN 1254-1 | **Copper and copper alloys. Plumbing fittings. Fittings with ends for capillary soldering or capillary brazing to copper tubes** | BSI Standards | 1998 | |
| BS EN 1254-2 | **Copper and copper alloys. Plumbing fittings. Fittings with compression ends for use with copper tubes** | BSI Standards | 1998 | |
| BS EN 1978 | **Copper and copper alloys. Copper cathodes** | BSI Standards | 1998 | |
| BS EN 1979 | **Copper and copper alloys. Cast unwrought copper products** | BSI Standards | 1998 | |
| BS EN 60079-14 | **Electrical apparatus for explosive gas atmospheres. Electrical installations in hazardous areas (other than mines)** | BSI Standards | 1996 | |
| BS EN 60529 | **Specifications for degrees of protection provided by enclosures (IP)** | BSI Standards | 1992 | |

| *Publication ID* | *Title* | *Publisher* | *Date* | *Notes* |
|---|---|---|---|---|
| BS EN 60601-1 | **Medical electrical equipment. General requirements for safety** | BSI Standards | 1990 | |
| BS EN 60898 | **Specification for circuit breakers for over current protection for household and similar installations** | BSI Standards | 1991 | |
| BS EN 60947 | **Specification for low-voltage switchgear and controlgear** | BSI Standards | 1998 | |
| BS EN 60947-2 | **Circuit-breakers** | BSI Standards | 1996 | |
| BS EN ISO 9000 | **Quality management and quality assurance standards** | BSI Standards | | |
| BS ISO 11195 | **Gas mixers for medical use – stand-alone gas mixers** | BSI Standards | 1995 | |
| **Scottish Health Technical Guidance** | | | | |
| SHTM 2007 | Electrical services: supply and distribution | P&EFEx | 2001 | CD-ROM |
| SHTM 2011 | Emergency electrical services | P&EFEx | 2001 | CD-ROM |
| SHTM 2014 | Abatement of electrical interference | P&EFEx | 2001 | CD-ROM |
| SHTM 2015 | Bedhead services | P&EFEx | 2001 | CD-ROM |
| SHTM 2022 | Medical gas pipeline systems | P&EFEx | 2001 | CD-ROM |
| SHTM 2025 | Ventilation in healthcare premises | P&EFEx | 2001 | CD-ROM |
| SHGN | Static discharges | P&EFEx | 2001 | CD-ROM |
| SHPN 1 | Health service building in Scotland | HMSO | 1991 | |
| SHPN 2 | Hospital briefing and operational policy | HMSO | 1993 | |
| SHTN 1 | Post commissioning documentation for health buildings in Scotland | HMSO | 1993 | |
| SHTN 4 | General Purposes Estates and Functions Model Safety Permit-to-Work Systems | EEF | 1997 | |
| | NHS in Scotland – PROCODE | P&EFEx | 2001 | Version 1.1 |
| **NHS in Scotland Firecode** | | | | |
| SHTM 81 | Fire precautions in new hospitals | P&EFEx | 1999 | CD-ROM |
| SHTM 82 | Alarm and detection systems | P&EFEx | 1999 | CD-ROM |
| SHTM 83 | Fire safety in healthcare premises: general fire precautions | P&EFEx | 1999 | CD-ROM |
| SHTM 84 | Fire safety in NHS residential care properties | P&EFEx | 1999 | CD-ROM |
| SHTM 85 | Fire precautions in existing hospitals | P&EFEx | 1999 | CD-ROM |
| SHTM 86 | Fire risk assessment in hospitals | P&EFEx | 1999 | CD-ROM |
| SHTM 87 | Textiles and furniture | P&EFEx | 1999 | CD-ROM |

| *Publication ID* | *Title* | *Publisher* | *Date* | *Notes* |
|---|---|---|---|---|
| SFPN 3 | Escape bed lifts | P&EFEx | 1999 | CD-ROM |
| SFPN 4 | Hospital main kitchens | P&EFEx | 1999 | CD-ROM |
| SFPN 5 | Commercial enterprises on hospital premises | P&EFEx | 1999 | CD-ROM |
| SFPN 6 | Arson prevention and control in NHS healthcare premises | P&EFEx | 1999 | CD-ROM |
| SFPN 7 | Fire precautions in patient hotels | P&EFEx | 1999 | CD-ROM |
| SFPN 10 | Laboratories on hospital premises | P&EFEx | 1999 | CD-ROM |
| **UK Health Technical Guidance** | | | | |
| EH 40 | HSE Occupational Exposure limits | HSE | Annual | |
| C54 | The keeping of LPG in cylinders and similar containers | HSE | | |
| MES | Model Engineering Specifications | NHS Estates | 1997 | As required |
| **Miscellaneous References** | | | | |
| | Model Water Byelaws: Dept. of the Environment | HMSO | 1986 | |
| | Occupations exposure standards for anaesthetic agents (EL(96)33). | Dept. of Health | 1996 | |
| | Advice on the implementation of the Health and Safety Commission's occupational exposure standards for anaesthetic agents | Dept. of Health | 1996 | |
| | Anaesthetic agents: controlling exposure under COSHH | Health Service Advisory Committee | | |
| | Code of practice 19: Bulk liquid oxygen storage at users' premises (Revision 2) British Compressed Gases Association | | 1996 | |
| | Medical gas pipe systems. Design and installation of (QAS 3720.1/206) | BSI/Dept. of Health | 1988 | |
| | Guidance notes for users of liquid cylinders of low pressure cryogenic liquid supply vessels for liquid oxygen, nitrogen or argon with capacity of under 450 litres (G4521) | BOC Gas | 1996 | |
| | Home Office Fire Prevention Guide No. 4: Safe use and storage of liquefied petroleum gas in residential premises. | | | |

| Publication ID | Title | Publisher | Date | Notes |
|---|---|---|---|---|
| | BDA Advice sheet A3 health and safety law for dental practice | BDA | 1993 | |
| EL(96)33 | Occupational exposure standards for anaesthetic agents | Dept. of Health | 1996 | |
| EH49/96 | Occupational exposure limits. | HSE | 1996 | |