

REFERENCE ONLY



**THE
BRITISH HYPERBARIC
ASSOCIATION**

**GUIDE TO FIRE SAFETY STANDARDS
FOR
HYPERBARIC TREATMENT CENTRES**

British Hyperbaric Association Technical Working Party

Guide to Fire Safety Standards for Hyperbaric Treatment Centres

July 1996

compiled by

Roly Gough-Allen (Chairman)
(Diving Diseases Research Centre, Plymouth)

John Abrahams
(South Western Regional Health Authority)

Mike Allen
(HyoX Systems Limited, Aberdeen)

Dave Elner
(DRA Alverstoke)

Graham McClue
(Hyperbaric Medical Services, Ellesmere Port)

Iain Middlebrook
(HSM Engineering, Loughborough)

© Copyright
The British Hyperbaric Association
1996

Published by
The British Hyperbaric Association
Dr JAS Ross (Chairman)
Department of Environmental and Occupational and Environmental Medicine
Medical School
Foresterhill
Aberdeen
AB9 2ZD
Tel: 01224 663123 ext 52524
Fax: 01224 662990

Printed by
Printing Services
University of Aberdeen
Regent Walk
Aberdeen
AB9 1FX

ISBN 0 9527623 1 5

The opinions, conclusions and recommendations contained in this report are those of the Committee and are not to be construed as official or necessarily reflecting the views of the British Hyperbaric Association.

TABLE OF CONTENTS

1.0 INTRODUCTION.....	4
1.2 DEPARTMENT OF HEALTH GUIDELINES	4
1.3 BUILDING REGULATIONS AND BRITISH STANDARDS	4
1.4 AIM OF GUIDANCE	4
1.5 INTERACTION WITH OTHER SAFETY REQUIREMENTS.....	4
1.6 ABBREVIATIONS.....	4
2.0 FIRE PREVENTION	5
2.1 OXYGEN CONCENTRATION.....	5
2.2 OXYGEN DUMPING	5
2.3 RECOMMENDED FABRICS.....	5
2.4 INFLAMMABLE MATERIALS.....	5
2.5 PAPER	5
2.6 CHAMBER EQUIPMENT.....	5
2.7 REMOVAL OF COMBUSTIBLES	5
2.8 ELECTRICAL EQUIPMENT.....	5
2.9 LUBRICATION.....	6
2.10 INFLAMMABLE GASES.....	6
2.11 EMERGENCY PROCEDURES.....	6
2.12 CONTINGENCY PLANNING	6
2.13 CLEANING.....	6
2.14 NUMBER OF CHAMBER OCCUPANTS	6
2.15 SMOKING.....	6
2.16 PROHIBITED MATERIALS	7
3.0 COMMUNICATION AND ALARM SYSTEMS	7
3.1 FIRE ALARM SYSTEM.....	7
3.2 FIRE DETECTORS.....	7
3.3 TESTING AND SERVICING OF ALARMS	7
4.0 ESCAPE	7
4.1 ARRANGEMENTS FOR ESCAPE	7
4.2 BREATHING APPARATUS	8
4.3 LOCAL FIRE PROCEDURES	8
5.0 EXTINGUISHING FIRES	8
5.1 FIRE EXTINGUISHERS IN THE CHAMBER.....	8
5.2 HANDLINES AND PRESSURISED HOLDING TANK	8
5.3 ALTERNATIVE WATER SUPPLIES	8
5.4 FIXED EXTINGUISHING SYSTEMS - DELUGE SYSTEMS.....	8
5.5 LOCAL FIRE BRIGADE.....	9
BIBLIOGRAPHY	10
APPENDIX 1 - EXAMPLES OF EMERGENCY PROCEDURES	11
APPENDIX 2 - MATERIALS PROHIBITED IN THE CHAMBER	16
GENERAL.....	16
LISTING	16
APPENDIX 3 - FIRE RISKS AND PRECAUTIONS WITHIN CHAMBERS USED FOR HYPERBARIC THERAPIES.....	17

1.0 INTRODUCTION

1.2 Department of Health Guidelines

Where new hyperbaric units are being installed as part of a District General Hospital then the guidance issued by the Department of Health under the title of "Health Technical Memorandum 81" should be used. The facility should be treated as a life risk compartment and provided with the same fire separation and means of escape as an Intensive Care Unit or Operating Department. Guidance for existing hospitals is contained in the Health Technical Memorandum 85 "Fire precautions in existing hospitals", similarly the Department providing Hyperbaric Therapy facilities should have the same fire safety provisions as an Operating Theatre Department.

1.3 Building Regulations and British Standards

The guidance presumes compliance with other legislation in particular the relevant Building Regulations which are applicable to new building work or a material change of use.

The building structure should normally be one hour fire resisting. For new buildings in England and Wales, advice on the standard for fire resistance and compartmentation is contained in the Building Regulations and the Approved Document B on Fire Safety. The construction of the chamber is controlled by BS 5500 "Design of unfired pressure vessels", Lloyds Class 1, PVHO, and/or other relevant National codes and standards; rather than the Building Regulations. Every effort should be made to reduce combustible materials to a minimum. The guidance can be used to assess the fire risk and determine suitable precautions. This should be done by a competent person, and the assessment recorded.

1.4 Aim of Guidance

This guidance cannot take account of all circumstances which may arise in hyperbaric treatment. It should therefore, be taken as a standard of safety to be achieved rather than a set of measures to be rigidly applied in all circumstances. Neither should the guide be used in isolation, it is still necessary to consult the appropriate Fire Authority on the individual situation.

1.5 Interaction with Other Safety Requirements

It is important in applying this guidance that other factors are considered such as any conflict with other safety requirements, the degree of supervision likely to be available and knowledge of specialist staff.

1.6 Abbreviations

To assist staff an abbreviated list of fire risks and precautions is attached as Appendix 3.

2.0 FIRE PREVENTION

2.1 Oxygen Concentration

The majority of fire prevention measures centre around the hazards of oxygen enriched fabrics and atmospheres. Atmospheres of 40% oxygen are extremely hazardous, but multiplace hyperbaric chambers normally operate at a range of less than 24% oxygen. In the higher concentrations further precautions are required. A means of analysing the oxygen levels in the chamber or chambers must be available. In normal practice, the chamber operator should keep a regular log of these readings. Monoplace chambers are not covered by this guidance, they may be pressurised on 100% oxygen so alternative guidance should be used.

2.2 Oxygen Dumping

Certain Treatment regimes require the breathing of oxygen by mask. Oxygen exhaled into the chamber will quickly raise the oxygen concentration. Even with venting it is difficult to keep the oxygen below 25%, although an increase of oxygen from 21 to 25% may not seem too great a change in percent terms, it is however enough to raise the burning rate by 25%. The best way to manage this situation safely, is to provide an overboard dump system for the exhaled oxygen.

2.3 Recommended Fabrics

Fabrics used in the chamber such as sheets, shall be of 100% cotton materials. Curtains or free hanging drapes should not be provided. If blankets are used they should be of a standard acceptable in the normal hospital environment (ref HTM87: Firecode), as a minimum standard. Specialist hyperbaric blankets such as Durette are available and should be used where the risk warrants it.

2.4 Inflammable Materials

The use of all sprays, hair and body oils are not permitted for all chamber occupants. Cosmetics, lotions and oils should be removed from body and hair wherever possible or practicable. Non-alcohol wipes are recommended for use in chambers. (a full list of prohibited materials can be found in appendix 2.)

2.5 Paper

The use of paper should be kept to a minimum within the chamber. It is recommended that newspapers are avoided and magazines limited in number.

2.6 Chamber Equipment

Equipment used inside the chamber should be kept to the minimum necessary for the operation of the chamber. Only equipment approved by the chamber facility manager should be allowed inside.

2.7 Removal of Combustibles

During treatment non-required combustible items should be "locked out" as a standard operating procedure.

2.8 Electrical equipment

All electrical equipment and wiring within chambers should comply with the relevant Regulations. The UK diving industry standard for electrical power in a chamber is 24 Volts

d.c.. Consideration should be given to the provision of local circuit breakers on any system. Any switches within the chamber must be intrinsically safe.

2.9 Lubrication

Any equipment requiring lubrication inside the chamber shall be lubricated with a suitable oxygen-compatible lubricant approved for the purpose to which it is put. Mineral oil or grease in an oxygen environment may cause fire or explosion.

Items introduced into the system containing mineral based oils or greases may also under certain conditions create an explosion when mixed with oxygen. For example wheel chairs with greased wheel bearings. A variety of lubricants will be required for the differing applications within the chamber.

2.10 Inflammable Gases

Flammable gases must be stored separately to the oxygen and oxidising gases and not in the chamber enclosure. The use of flammable agents inside a hyperbaric facility or in proximity to any air intake is forbidden. Gas burners and lighters should not be permitted in the chamber area.

2.11 Emergency Procedures

Emergency procedures (for an example see appendix 1) best suited to the needs of the particular building and facility must be established. All personnel should be instructed on these procedures as a form of induction training. Personnel should be trained to safely decompress occupants when all powered equipment has been rendered inoperative. These procedures should be practised at regular intervals. The contingency plan should identify the alternative hyperbaric unit as in paragraph 4.1.

2.12 Contingency Planning

A contingency plan must be developed clearly defining the responsibilities and activities of all personnel in the event of an emergency. This should confirm that the chamber control is the emergency co-ordinator and should specifically identify action plans to be implemented as the situation develops. This plan should be developed as part of an overall strategy if the hyperbaric unit forms part of a larger hospital or clinic complex. It should be discussed and lodged with the local fire department.

2.13 Cleaning

It is absolutely essential that all areas of the hyperbaric chamber and the associated plant are kept free of grease, lint, dirt and dust. A regular cleaning programme must be introduced and maintained. Those responsible for cleaning must be given the appropriate induction training. Cleaning materials must be approved by the chamber facility manager.

2.14 Number of Chamber Occupants

The number of occupants of the chamber should be kept to the minimum necessary to carry out the procedure with due allowance for training of personnel.

2.15 Smoking

There is to be No Smoking in the chambers or in the immediate chamber and control areas.

2.16 Prohibited Materials

An appendix (2) of "materials prohibited in the chamber" is included as guidance for staff of hyperbaric treatment units.

3.0 COMMUNICATION AND ALARM SYSTEMS

3.1 Fire Alarm System

The Department or facility should have an alarm system capable of detecting smoke or fire and to raise the alarm and signal the pre-arranged evacuation. It will, therefore, have to be designed to the standards of BS5839: Part 1: 1980 'Fire detection and alarm systems in buildings' with further pertinent advice in Health Technical Memorandum HTM82.

However, the guidance is no substitute for adequate discussion of what is to be expected by way of alerting staff and assisting in the rapid location of the fire source, any fire containment measures or extinguishment of the fire. The type of warning signal will require discussion and the importance of the chamber control as the co-ordinator of any emergency activity must be recognised. The alarms should therefore cover all areas including plant and circulation spaces, but the signal to the chamber must be routed by the chamber control console. It is advisable for some form of visual signal to be given at chamber control when there is a fire condition.

3.2 Fire Detectors

Advice on the siting of detectors and the choice of detector head can be found in the guidance mentioned in paragraph 3.1 supplemented by advice from the fire prevention officer of the Local Fire Authority.

3.3 Testing and Servicing of Alarms

Testing of the alarm system and servicing should be carried out as recommended in the British Standard. Normally, a weekly system healthy check, and an annual engineer service should be sufficient.

4.0 ESCAPE

4.1 Arrangements for Escape

Arrangements for escape in a hyperbaric treatment unit will depend on the fire evacuation strategy to be adopted. Most staff and visitors will leave on the fire evacuation signal, this will not be immediately practicable or possible for those undergoing treatment and those at chamber control.

The treatment of non diving related patients should be aborted immediately an emergency situation is confirmed. These persons should be evacuated as quickly as possible.

It may be possible to consider moving hyperbaric patients and their attendants to a pre-determined place of safety, in some situations this may mean having emergency arrangements to transfer them to an alternative chamber within an appropriate time scale. The alternative chamber should be located in a separate building or location. In a large

compartmented building in may be acceptable for the facility to be provided in a separate fire compartment with independent engineering systems.

4.2 Breathing Apparatus

Consideration should be given to the provision of Breathing Apparatus for staff assigned to chamber evacuation or life support. Suitable training needs to be addressed.

4.3 Local Fire Procedures

An example of local fire procedures is given as appendix 1 to this document.

5.0 EXTINGUISHING FIRES

5.1 Fire Extinguishers in the Chamber

A form of first aid fire fighting must be provided in the chamber. This can be a fire bucket containing water or an approved specialised pressure water extinguisher.

Experience has shown that fire blankets and portable carbon dioxide extinguishers are not effective in controlling fires in oxygen-enriched atmospheres.

On no account must a standard water, water/foam, CO₂, dry powder or Halon extinguisher be present inside the pressure chamber as some types are toxic in confined spaces.

Approved special modified pressure foam/water units have been designed to operate at multi-level pressures incorporating a pressure relief device, and containing a non-toxic foam. The propellant gas must be compatible with the breathing mixture.

5.2 Handlines and Pressurised Holding Tank

The use of ½ in. (12.5 mm) water handlines is acceptable. However these handlines should be supplied from the water main via a holding tank (unless 5.3 or similar is adopted)which will assure 7 bar (100 psi) minimum water pressure above the maximum hyperbaric chamber pressure.

5.3 Alternative Water Supplies

A system which can provide an adequate supply of water at the necessary pressure and volume may be acceptable. This would eliminate the necessary for a pressurised water holding tank.

5.4 Fixed Extinguishing Systems - Deluge Systems

For new installations a fixed extinguishing system may be installed within chambers. It shall be capable of manual activation. When operated the system activation shall occur within one second.

The limit on duration of application of the fixed system in chambers shall be governed by the capacity of the chamber and its drainage system. There shall be sufficient water available to maintain an adequate flow for approximately one-minute duration. Extinguisher controls shall be located both inside and outside the chamber.

Since inadvertent discharge of water can disrupt operation of the facility, proper precautions to prevent such an occurrence should be observed.

The duration of application is governed by the type of system. The quantity of water discharged shall provide the necessary concentration or saturation throughout the chamber for complete extinguishment.

Sufficient spray nozzles shall be installed to provide reasonably uniform and adequate coverage with horizontal and vertical jets.

Experience has shown that when water is discharged through conventional sprinkler heads into a hyperbaric atmosphere the spray angle is reduced because of the increased density of the atmosphere even though the water pressure differential is maintained above atmospheric pressure. Therefore, it is necessary to compensate by increasing the number of sprinkler heads.

The system design shall be such that prior to activation of the water deluge system, interior chamber power shall be deactivated first.

A bypass circuit shall be permitted for testing the water deluge system. If installed, the circuit shall be so designed as not to remain in the test mode. The design of the system should allow for frequent movement of water to avoid any stagnation within the pipework and holding tanks.

5.5 Local Fire Brigade

Local fire-fighters should familiarise themselves with the risks present in hyperbaric chambers, in particular the risks from pressurised components.

BIBLIOGRAPHY

- * Building Regulations 1992 and Approved Document "B" Fire Safety (England and Wales) Building Standards (Scotland) Regulations and associated guidance.
- * Building Regulations (Northern Ireland) 1994 and Technical Booklet "E" Fire Safety.
- * FIRECODE: Health Technical Memorandum 81: Fire Precautions in new hospitals
- * FIRECODE: Health Technical Memorandum 82: Fire alarm and detection systems
- * FIRECODE: Health Technical memorandum 85: Fire precautions in existing Hospitals
- * FIRECODE: Health Technical memorandum 86: Fire assessment in hospitals
- * FIRECODE : Health Technical Memorandum 87: Textiles and Furniture
- * FIRECODE: Nucleus Fire Precautions Recommendations
- * BS5839: Part 1: 1980: Fire detection and alarm systems
- * BSD5500: Design of unfired pressure vessels.
- * Health Technical Memorandum 2022: Medical Gas Systems
- * Works Officer letter WK0(85)1: Bulk Storage of Oxygen
- * Draft Guide to fire precautions in existing residential care premises
- * FIRECODE: Health Technical Memorandum 84: Fire Safety in residential care premises.
- * National Fire Protection Association NFPA-99 -
American Standards for Health Care facilities
(Chapter for Hyperbaric facilities)
- * Chamber Fire Safety
Undersea Medical Society Inc.
- * Commercial Diving Reference and Operations Handbook
(Published by John Wiley & Sons)
- * Code of Practice for the Safe Use of Electricity Under Water
(Published by the Association of Offshore Diving Contractors now the International Marine Contractors Association)

APPENDIX 1 - EXAMPLES OF EMERGENCY PROCEDURES**IN CASE OF FIRE (STAFF)**

- 1 In the event of fire it is the first duty of all concerned to prevent injury or loss of life.
- 2 For this purpose, you should make certain that you are familiar with the fire routine, all routes of exit from the building and the location and use of the fire fighting equipment and the methods of rescue appropriate to this establishment, depending on whether chambers are in use. If so get advice from Chamber Control.
- 3 **IF YOU DISCOVER A FIRE** or one is reported to you, you should:-

BREAK THE GLASS OF THE NEAREST FIRE ALARM CALL POINT
- 4 The most senior member of staff on duty is responsible for calling the fire brigade immediately on hearing the fire alarm. This can be done by telephone. Dial '999'.
- 5 On hearing the fire alarm, a senior designated member of staff should:-
 - (a) Check the location of the fire and inform Chamber Control.
 - (b) Respond to the area where the fire is located. Commence evacuation of the area in accordance with the Detailed Fire Drill Procedure. Ensure doors through which you pass are closed after you.
 - (c) When the fire service arrives, follow the instructions of the Officer in Charge.

IN CASE OF FIRE (NON STAFF)

- 1 **GIVE THE ALARM IMMEDIATELY BY BREAKING THE GLASS OF THE NEAREST FIRE ALARM CALL POINT**
- 2 The premises will be evacuated on the hearing of the **ALARM** all persons will assemble at:

.....
ACT QUIETLY

USE THE NEAREST AVAILABLE EXIT

DO NOT STOP TO COLLECT PERSONAL BELONGINGS
- 3 No one should re-enter the premises until told by a Fire Service Officer that it is safe to do so.

IN CASE OF FIRE WITHIN THE CHAMBER

- 1 **GIVE THE ALARM IMMEDIATELY BY BREAKING THE GLASS OF THE NEAREST FIRE ALARM CALL POINT.**
- 2 The premises will be evacuated on the hearing of the **ALARM**. All persons will assemble at:

.....
- 3 The safety of chamber occupants will be catered for by the Chamber operator on duty.

DETAILS OF FIRE PROCEDURES

Memo to Staff

Please note [.....] are **NO SMOKING AREAS** with the exception of the [.....].

In the event that hazardous maintenance work is in progress and the chamber is required, all work will normally cease until the therapy is completed.

PLEASE SEE [.....] PLAN FOR THE POSITION OF

- Halon fire extinguishers
- Dry Powder extinguishers
- Fire Blankets
- Chamber extinguishers
- CO₂ Fire Extinguishers

If you do not know how extinguishers work, then ask to be shown.

Members of staff are:-

[List of all staff and duty times]

.....

IN THE EVENT OF A FIRE IN THE BUILDING WHEN THE CHAMBERS ARE NOT IN USE

- 1 In the event of fire it is the first duty of all concerned to prevent injury or loss of life.
- 2 For this purpose, you should make certain that you are familiar with the fire routine, all routes of exit from the premises and the location and use of the fire fighting equipment. The most senior member of staff present is to call the Fire Service by telephone.
dialling '999' and give the Fire Service our full address.
- 3 **SOUND THE ALARM BY BREAKING THE GLASS OF THE NEAREST FIRE ALARM CALL POINT.** Attempt to fight the fire only if safe to do so.
- 4 **LEAVE THE BUILDING** by the nearest exit and assemble at the Make sure someone has called the Fire Service and a roll-call of all staff and patient taken.

IN THE EVENT OF A FIRE IN THE BUILDINGS WHEN THE CHAMBER COULD BE SURFACED WITH MINIMAL RISK TO THE OCCUPANTS

- 1 In the event of fire it is the first duty of all concerned to prevent injury or loss of life.
- 2 For this purpose, you should make certain that you are familiar with the fire routine, all routes of exit from the premises and the location and use of the fire fighting equipment. Inform Chamber Control immediately so that they can start to surface the chamber and occupants can be evacuated to another chamber [alternative Chamber]. The Chamber operator is to be in charge of the care of all persons in the chambers. Attempt to fight the fire only if it is safe to do so.

- 3 **IF YOU DISCOVER A FIRE** or one is reported to you, you should:-

SOUND THE ALARM. The most senior member of staff on duty is responsible for calling the Fire Brigade immediately on hearing the fire alarm. This can be done from any phone, dial "999".

- 4 **SOUND THE ALARM BY BREAKING THE GLASS OF THE NEAREST FIRE ALARM CALL POINT.** The premises will be evacuated on the hearing of the **ALARM**. All persons will leave the premises by the nearest exit and report to the Make sure someone has called the Fire Service and a roll-call of all staff and patients is taken.

EMERGENCY TELEPHONE NO: [of alternative chamber]
.....

Request Duty Officer and state diving emergency.

IN THE EVENT OF A FIRE IN THE BUILDING WHEN THE CHAMBER IS IN USE BUT CANNOT BE SURFACED

- 1 In the event of fire it is the first duty of all concerned to prevent injury or loss of life.
- 2 For this purpose, you should make certain that you are familiar with the fire routine, all routes of exit from the premises and the location and use of the fire fighting equipment. Inform Chamber Control immediately so that all possible actions can be taken to fight the fire only if it is safe to do so and move the occupants into another chamber, if appropriate, by blowing down connecting chambers. All external chamber valves not absolutely necessary must be shut to maintain depth, and covers inserted over ports. Chamber Operators will remain on Chamber Control for as long as it is safe to do so. When the Fire Service arrive, breathing apparatus will be issued to the Chamber Operator. A Fire Officer will then stay on Chamber Control for as long as the Chamber Operator can remain. Make sure there are emergency respirators and plenty of CO₂ absorbent available in the chamber or BIBS for all occupants with an adequate supply of breathing gas and in the event that Chamber operators cannot stay in the building then ask the inside attendant to close all inside chamber skin valves.
- 3 **SOUND ALARM BY BREAKING THE GLASS OF THE NEAREST FIRE ALARM CALL POINT.** Attempt to fight the fire only if safe to do so.
- 4 **LEAVE THE BUILDING** by the nearest exit and assemble at the
Make sure someone has called the Fire Service and a roll-call of all staff and patients taken.

APPENDIX 2 - MATERIALS PROHIBITED IN THE CHAMBER**General**

The following items comprise a reasonably comprehensive listing of items and materials that should not be allowed into the chamber. The letter(s) following each item indicates the general reason for prohibiting it, the coding is shown below.

- C possibility of damaging the fabric of the chamber.
- D contamination of the environment.
- E explosion risk.
- F fire source or a combustible substance.
- L could be broken or damaged by pressure.
- M will possibly cause a mess.
- P affects ability of diver.

Listing

- a Adhesives (F).
- b Aerosols (D,E,F).
- c Aftershave and cosmetics (D,F).
- d Alcohol (D,F,P).
- e Batteries with unprotected leads (F).
- f Chemical cleaners, e.g. trichloroethylene, 'Freon', etc. (D,P).
- g Cigarettes, cigars, tobacco of all kinds (F,M).
- h Cleansing powder (C,F,P).
- i Volatile Drugs (P,F).
- j Electrical equipment including tape recorders, radios, etc. (F).
- k Explosives.
- l Glass thermometers including batteries containing mercury.(C,D,P)
- m Ink pens (M).
- n Lighters (F).
- o Matches (F).
- p Non-diving watches (L,M).
- q Petroleum based lubricants, greases, fluids (F).
- r Sugar and fine powder and other flammable food stuffs.(E,F)
- s Thermos flasks (L,P).
- t Non-fire-retardant, bedding including blankets, sheets, pillows, mattresses, etc. except 100% cotton or treated materials.(F)

APPENDIX 3 - FIRE RISKS AND PRECAUTIONS WITHIN CHAMBERS USED FOR HYPERBARIC THERAPIES

The information listed in this appendix covers fire risks which may be experienced in therapy chambers using compressed air environments between 1 and 6 bar.

Area of Risk	Source	Precaution
1. Raised pressure	a - Fire risks in compressed air environments are greater than at one atmosphere, i.e. ease of ignition and rate of burning is enhanced in compressed air atmospheres.	System should be so designed as to minimise the risk of fire and, in the event of such, procedures and hardware should exist to maintain life and minimise damage, i.e. fire extinguishing devices, BIBS, chamber fire procedures, chamber evacuation procedures.
	b - The physical features of the functional therapeutic chamber multiply the hazards of even a very small fire, by containing personnel and restricting escape. One of the most obvious actions to be taken in the event of a fire would be to evacuate the affected compartment, isolating personnel from the danger of fire and noxious gases. In many cases this will not be practical, or at least hampered by the condition of the patient.	Hyperbaric fire fighting equipment should be fitted in all chamber compartments.
	c - Decompression obligations will negate, or at least delay, evacuation from the hazardous environment.	

Area of Risk	Source	Precaution
2. Raised oxygen percentage.	a - BIBS leakage when administering oxygen and oxygen enriched gases (>21%)	Correctly fitting oral nasal masks; provide adult and child sizes. Use BIBS, incorporating an 'overboard dump' so exhausting expired oxygen enriched gases from within the chamber. Regularly maintain system, check for leaks prior to use. A flexible extension tube from the internal gas sampling line may be used to discover system leaks during operation.
	b - Atmosphere replenishment	Oxygen replenishment systems should introduce gas into the chamber so as to facilitate mixing, e.g. oxygen could be bled into external regeneration return lines; onto internal scrubber fans; jetted at short bursts into the top of the chamber. Oxygen analysers may be fitted with 'high' and 'low' alarms.
	c - Patient ventilator	Fit scavenge line to the patient ventilator exhaust so drawing off oxygen-enriched gases expired by the patient and dumping it outside the chamber. In all cases chamber oxygen should be maintained below 24%; concentrations above this will require flushing through with air. (If ventilator is driven with oxygen then this will need drawing off to the overboard dumps.)

Area of Risk	Source	Precaution
3. Flammable atmospheres	a - Dust in suspension in a dry atmosphere	All gas lines should incorporate gas filters; chamber furnishings should be lint free; chamber should be cleaned out daily.
	b - Volatile substances	Spirit based medical wipes are not recommended for use in the chamber. Volatile drugs should be preloaded into syringes outside the chamber. Patients, their clothing and bedding, should be void of spirit based preparations, aftershave and perfumes, hair spray, pens containing spirit based inks (see Appendix 2). All persons entering the chamber should be checked and relieved of these substances.

Area of Risk	Source	Precaution
4. Flammable Materials	a. Clothing flammability	Chamber occupants should wear cotton-based materials, clean and free from oil and grease.
	b. Bedding and chamber soft furnishing: flammability	Material of a standard acceptable to hospital use should be employed. Keep all bedding to a minimum, as required for the therapy.
	c. Food stuffs: flammability low flashpoint	Certain foods are inherently flammable and should not be introduced into the chamber in a raw state, e.g. sugar (should be premixed into drinks), butter etc. (should be pre-spread onto bread).
	d. Lubricants: low flashpoint	Only permitted lubricants should be used within the chamber, and on any equipment that may be introduced into it, e.g. ventilators, aspirators, stretchers etc. All such equipment should be checked and authorised before use.
	e. Paints	Chamber surfaces to be painted with non-toxic materials, and of minimum thickness. Flaking paint should be feathered in and patched as soon as possible; thin sections will ignite readily.
	f. Electrical insulation	Use fire retardant, insulated wiring.

Area of Risk	Source	Precaution
4. Flammable materials (contd.)	g. Medical Supplies	Flammable materials, such as tissues, medical wipes and bandages, should be kept to a minimum and may be stored in covered metal containers or drawers. Used materials should be passed out of the chamber as soon as convenient.
	h. Paper products	These should be kept to a minimum. Rubbish should be passed out of the chamber as soon as convenient.
	I. Imported items	<p>All personnel entering the chamber, regardless of whether it is to be pressurised or not, should declare all equipment they intend to take in with them so that it may be vetted by the system operator.</p> <p>A notice containing the following or similar information should be prominently displayed over entry doors and medical lock doors:</p> <p>WARNING: FIRE AND TOXICITY RISK No flammable or toxic materials, such as lighters, matches, flammable liquids, oil containing articles or clothing, are to be taken into the chamber. Instruments containing mercury, are <u>never</u> to be taken into the compression chamber. Remember the flammable and toxic danger from drugs etc.</p> <p>Staff should be briefed prior to entering the chamber, the above restrictions being enforced.</p>

Area of Risk	Source	Precaution
5. Electrical systems	a. Chamber fires may be caused by electrical defects	<p>Electrical equipment should be kept to the absolute minimum; that which is employed should comply with the relevant regulations and standards. All systems should be protected by RCDs (ELCBs), trips being located in the main control area.</p> <p>All systems should be regularly maintained and checked.</p>
	b. Motors, i.e. scrubbers.	Should be encased in metal, brushless and switched externally.
	c. Switches and connectors	Power supplies should be located outside the chamber and initiated by external switching. Only intrinsically safe switches should be used inside the chamber.
	d. Lighting	Only hyperbaric compatible lighting should be used inside the chamber.
	e. Battery powered equipment	Medical equipment normally powered by internal batteries should be kept to a minimum. As a rule batteries should not be allowed in the chamber (though we know those of certain construction/materials cannot contaminate the environment).