

Multiplace Hyperbaric Chamber Delivery Systems

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The Multiplace Hyperbaric Chamber

Configuration & Operational Overview

Primary Training in Hyperbaric Medicine
Columbia, South Carolina

- ### Operational, Research & Clinical Settings
- Military (diving & aviation)
 - Commercial, professional & industrial diving worksites
 - Recreational diving destination support
 - Civil engineering (caisson & tunnel projects)
 - Academic hyper-hypobaric programs
 - Clinical hyperbaric medicine

The Class A Hyperbaric Chamber

'Human, multiple occupancy' NFPA-99 classification system

Multiplace hyperbaric delivery system fundamentals

- Chamber configuration
- Air compression & medical gas delivery systems
- Fire suppression capabilities
- Standard operating, clinical, safety & compliance characteristics

- ### Chamber Nomenclature
- Main compartment vs. main lock/inner lock
 - Entrance compartment vs. entry/outer lock
 - Hatch vs. man way; 'door' on modern clinical units
 - Medical lock vs. supply lock
 - View port vs. window
 - Inside attendant vs. tender/medic





Hatches open into compartment they seal

Outer compartment cannot be pressurized to greater degree than inner compartment

Hatches sealed by pressure differential, not by securing devices



Anti-suction protection, isolation valves; identification



Chamber Air Compression Options

Low pressure compressor > LP volume receiver
125-200 psig

High pressure compressor > HP storage receiver
>2,000 psig

High pressure storage cylinders
>2,000 psig

Low Pressure Compressor Types

Internal combustion engine

Rotary screw



Compressor supplies chamber via air 'receiver'

small reserve for initial compression

receiver air initially cooler than direct compressor air



Air Purity

Compressors: responsibility of end users

Cylinders: responsibility of product manufacturer/supplier

~wide range of standards

Oxygen percent

Carbon dioxide; carbon monoxide

Oil vapor; water vapor

Sulphur dioxide; nitrogen dioxide

Nitric oxide, other potential contaminants

Filtration of Compressed Air Supply

Filter types

Particulate; to remove particles & dust

Activated carbon; removes odors & gases

Coalescing; aerosols to droplets, for drainage



Medical Gases

100% oxygen, clinical HBO therapy

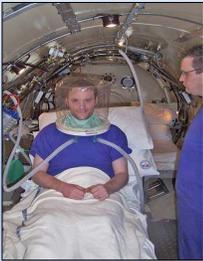
Nitrox (nitrogen oxygen mixtures)

Heliox (helium oxygen mixtures)



Patient Oxygen Delivery Systems

- No ¼ turn valves on HP system; metering types only
- Pressure reduction to source, if HP cylinders
- Control panel Oz analyzer
- 'Overboard dump' mandatory





Fire Suppression/Extinguishment Options

- Fire blankets
- Handheld extinguisher; water or foaming agents
- Water supplied hand line (hose)
- Water supplied deluge system

Fire Blankets

- Small portable deck decompression chambers
- Not permitted in Class A chambers (NFPA 99)





Handheld Fire Extinguisher




Mandatory Class A chambers (NFPA 99)

- Water & power (air pressure) must be independent of water deluge system
- Water pressure must be 50 psig > chamber working pressure
- One hose in every compartment, two in larger compartments
- Sufficient water volume for not < than 4 min



Water Deluge System

- Mandatory Class A chambers (NFPA 99)




Water storage tank

Air pressure volume tank

Water Deluge System

Water & power (air pressure) supplies must be independent of headline

Water deluge must be delivered three seconds of activation

should be sufficient available volume to flow for one minute

should have sufficient stored power (pressure) to operate for 15 seconds

Water Deluge System

Manual activation & deactivation at control panel & inside chamber

Automatic activation not required; surveillance detection is (CCTV)





Evolution of flame detection - automatic activation standard

First edition NFPA-56 DT 1968

"A fixed fire extinguishing system shall be installed in all Class A chambers. It will be capable of manual, as well as automatic, activation"



NFPA 99, Chapter 19 1993

While the requirement for a fixed extinguishing system remains...

"Automatic fire detection systems are optional"

If installed...

"Surveillance fire detectors responsive to the radiation from flame shall be employed"

NFPA 99, Chapter 20, 2002

"Automatic fire detection systems shall not be required"

Inside Attendant

"Fitness to work in pressurized settings" along lines of HBO pts. but compressed air issue

Pregnancy temporary disqualification screening standards not well established

Nitrogen narcosis non-issue with routine HBO therapy complicates DCI cases tx > 100 fsw

historic standard of 165 fsw for CAGE & DCS

issues of personal safety, pt care & clinical decision-making

UHM JOURNAL, 44, No. 2 - POLICY GUIDELINES FOR MULTITABLE HYPERBARIC CHAMBERS

Policy

UHMS Medical Fitness to Work Guidelines for Multitable Inside Attendants

Report of the Hyperbaric Oxygen Safety Committee of the Undersea and Hyperbaric Medical Society

This document was written and reviewed by members of the Safety Committee of the UHMS and approved by the UHMS Board of Directors

Purpose

The publication does not replace or supersede and does not diminish the responsibility of the individual attendant for the safety of the patient and the safety of the attendant. It is intended to provide a minimum standard for the selection and training of attendants. It is intended to provide a minimum standard for the selection and training of attendants. It is intended to provide a minimum standard for the selection and training of attendants.

Authorship

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Alleman T. UHM 2018;45(2):231-247

Same pressure (barotrauma) related risks as patients

Also, at risk for decompression sickness several cases annually; two nurse fatalities

Procedures to limit DCS incidence

well hydrated; avoid cramped positions

O2 breathing interval prior to & during ascent

rotating personnel

avoid repetitive exposures

interval before flying >24 hrs.



UHM 2017;44, No. 6 - HEALTH CARE WORKERS

Health care worker decompression sickness: incidence, risk and mitigation

Background: DCS is a life-threatening condition that can occur in health care workers who are exposed to compressed air during hyperbaric oxygen therapy. This document provides information on the incidence, risk, and mitigation of DCS in health care workers.

ABSTRACT

Decompression sickness (DCS) is a life-threatening condition that can occur in health care workers who are exposed to compressed air during hyperbaric oxygen therapy. This document provides information on the incidence, risk, and mitigation of DCS in health care workers.

KEYWORDS

decompression sickness, hyperbaric oxygen, health care workers, incidence, risk, mitigation

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Routine Chamber Operations

Chamber compression on air to pre-determined depth
*traditionally 45 fsw/2.36 ATA; 33 fsw/2.0 ATA common with hoods
 mandatory BIBS for every occupant
 O₂ breathing upon arrival to pressure*

Chamber O₂ constantly monitored; upper limit 23.5%
*most common source of O₂ leaks is BIBS
 air flushing to maintain acceptable range*

Entry lock at 1.0 ATA

Medical lock for small supplies transfer
ampules; vials



Patient/Chamber Safety Perspectives

No direct patient grounding required (as required for monoplace)
exception when O₂ atmospheres > 23.5% employed

Chamber grounding per monoplace, plus internal conductive surfaces
 enclosing electrical circuits

Ear protection during compression & ventilation

Chamber pressure relief valves
*one for chamber max working pressure
 optional second for max O₂ breathing pressure*

Patient/Chamber Safety Perspectives

14.2.7.3.17.5 Battery-Operated Devices

Battery-operated devices shall meet the following requirements:

- (1) Batteries shall be fully enclosed and secured within the equipment enclosure.
- (2) Batteries shall not be damaged by the maximum chamber pressure to which they are exposed.
- (3) Batteries shall be of a sealed type that does not off-gas during normal use.
- (4) Batteries or battery-operated equipment shall not undergo charging while located in the chamber.
- (5) Batteries shall not be changed on in-chamber equipment while the chamber is in use.
- (6) The equipment electrical rating shall not exceed 12 V and 48 W.
- (7) Lithium and lithium ion batteries shall be prohibited in the chamber during chamber operations, unless the product has been accepted or listed for use in hyperbaric conditions by the manufacturer or a nationally recognized testing agency.

"Intrinsically Safe" Hyperbaric Practice

Keeping level of electrical energy too low to cause ignition
thereby preventing sparks & keeping temperature low

Device designs that exclude oxygen
plus, purging device with inert gas

Device strong enough to contain explosion

Moving devices outside hazardous (chamber) area

