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

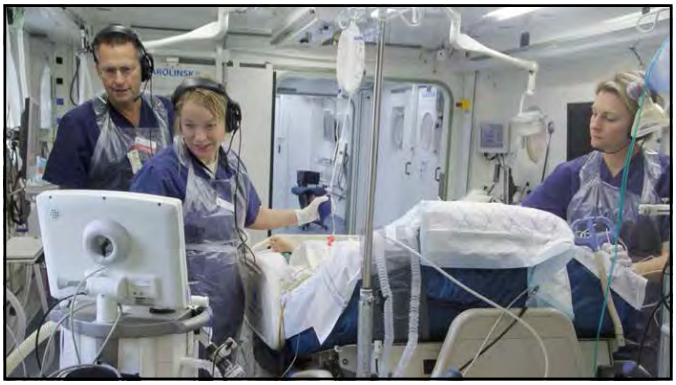
'Human, multiple occupancy' *NFPA-99 classification system*

Multiplace hyperbaric delivery system fundaments

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

Chamber Nomenclature

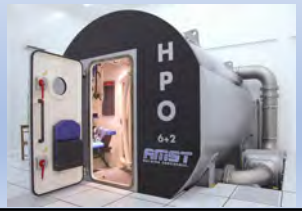
- Main compartment vs. main lock/inner lock
- Entrance compartment vs. entry/outer lock
- Hatch vs. man way; 'door' on modern clinical units
- Medical lock vs. supply lock
- View port vs. window
- Inside attendant vs. tender/medic



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: responsibly 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

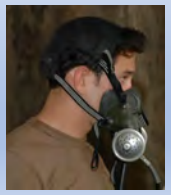
100% oxygen, clinical HBO therapy

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 O_2 analyzer
- 'Overboard dump' mandatory

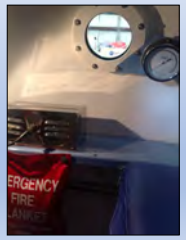


Fire Suppression/Extinguishment Options

- 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 Deluge System

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

Water deluge must be delivered three seconds of activation

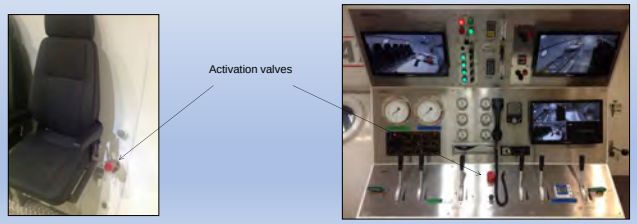
should be sufficient available volume to flow for one minute

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...

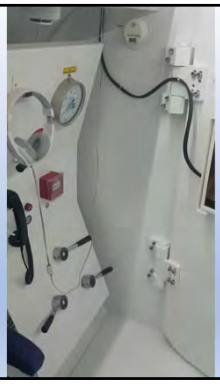
"Automatic fire detection systems are optional"

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

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.

Health care worker decompression sickness: incidence, risk and mitigation

Clarke R. UHM 2017;44(6):509-519

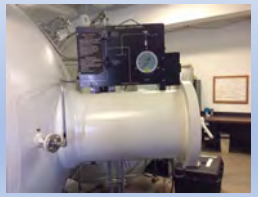
Routine Chamber Operations

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 tx pressure

Chamber O2 constantly monitored; upper limit 23.5%
most common source of O2 leaks is BIBS
air flushing maintains acceptable range
upper & lower sample take-off points

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
internal & external overrides

Battery powered equipment
sealed/pressure resistant; no in-chamber charging; no battery changing
personal items (cell phone; laptop; tablet; pager; entertainment) prohibited

"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