

HYPERBARIC SAFETY 2025

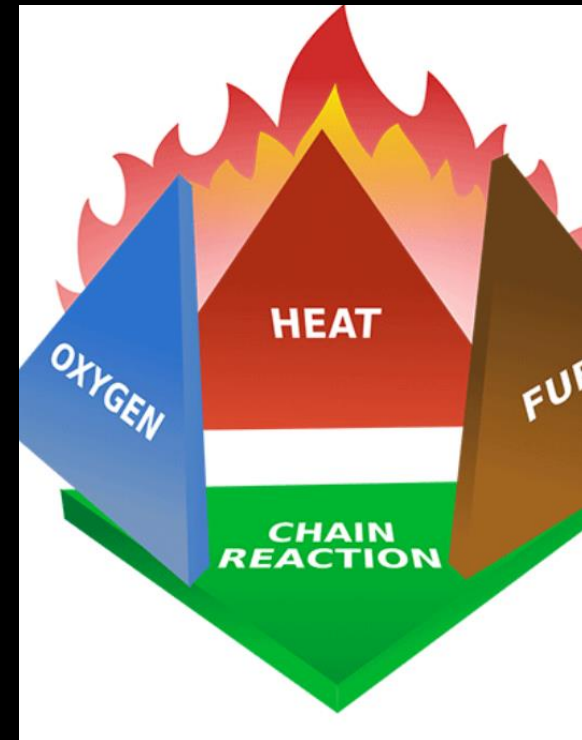
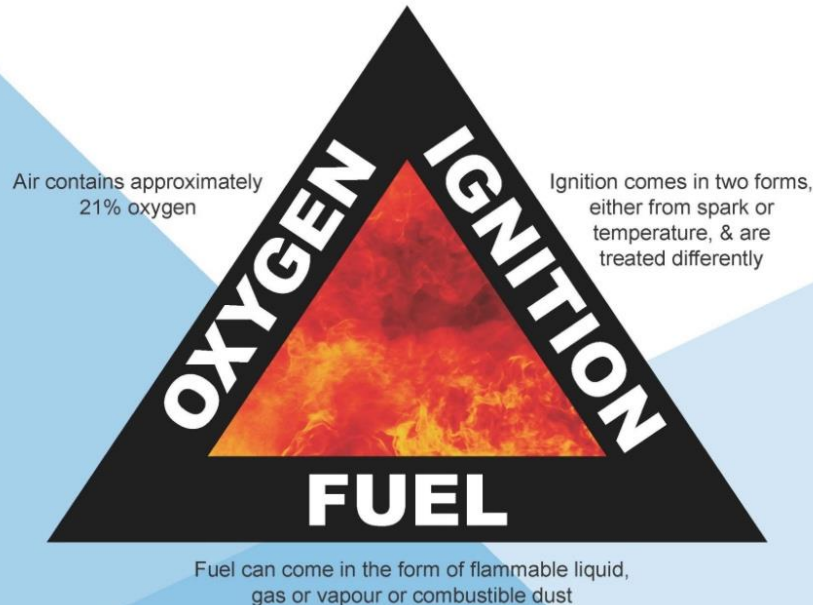
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CLASS A HYPERBARIC MISHAPS 2025

- Troy Michigan- 31 January 2025
 - Death of 5 year old patient
 - Probable Cause – Static follow by fire
 - Contributing Factors- Grounding strap absent, excessive movement, Linens, pillow, blanket (suspected synthetic)
 - 2 ATA- 9ATA (2-3 sec) Pressure Discharge through door seals
 - Video taped
- Lake Havasu City 9 July 2025
 - Death of 43 year old owner
 - Probable Cause: Thermal Runaway Lithium-Ion Battery
 - Numerous electronic devices- with Lithium-Ion Batteries

the fire triangle

Fire needs three things to exist; Oxygen, ignition and fuel.
Eliminate one and a fire will not occur.



Troy MI 31 Jan 2025

Static generation through movement

Static electricity and failure of static suppression
25 Accidents in 101 years both in Mono and Multi

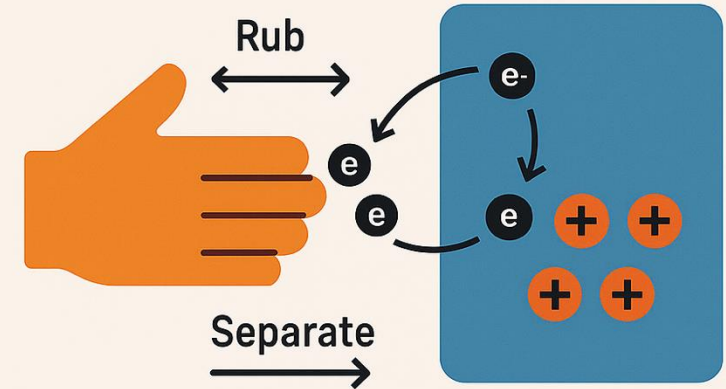
Humidity – with 425 litres/min approximately 30%

No grounding Strap

11 major position shifts over multiple surfaces prior to the flash
fire

TRIBOELECTRICITY

The generation of static electricity through friction or separation



IN A HYPERBARIC OXYGEN ENVIRONMENT



A static discharge can ignite flammable materials

- Antistatic clothing
- Proper grounding
- Adequate humidity

Key NASA Findings Relevant to HBOT

- At 100% O₂, ignition thresholds drop dramatically:
 - Ambient air (21% O₂): ~60–80 mJ required.
 - 50% O₂: ~20–30 mJ required.
 - 100% O₂: as low as 8–9 mJ.
- Triboelectric static discharges from patient blankets or chamber linens can exceed 25–30 mJ, placing them well into the danger zone.
- Lithium-ion battery failures generate low-energy sparks (<5 mJ) but in oxygen-rich chambers → ignition is highly probable.

Zone	1.0 ATA (reference)	2.0 ATA (use for HBOT policy)	Implication
 Safe	< ~8–9 mJ MIE typical in 100% O ₂	Treat < ~3–4 mJ as unsafe anyway	Operate as if any spark is unacceptable.
 Caution	~8–20 mJ	~3–10 mJ	Tiny discharges can ignite— tighten controls .
 Danger	> 20 mJ	> 10 mJ	Routine tribo sparks & micro-arcs are clearly igniting .

Bottom line: At 2.0 ATA / 100% O₂, act as if **sub-5 mJ** discharges can ignite. In practice, **zero-spark tolerance** is the only safe standard.

Lake Havasu City AZ

7 Electronic Devices with Li-Ion Batteries

- Possible Oxygen Enriched Environment

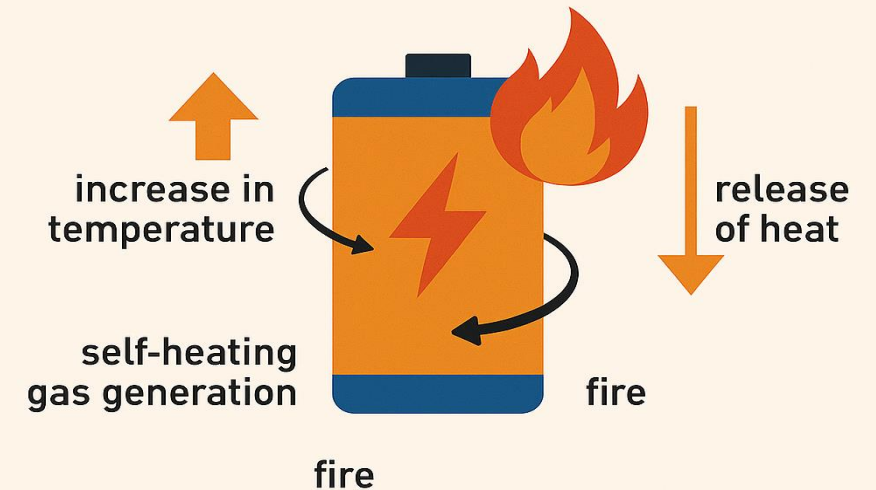
% of Oxygen	Temp (c)	Burn Time sec
21%	350-400	5
23%	800	5
30%	1000-1200	12
100%	1700	15

Conditions That Can Trigger Thermal Runaway

- Overcharging
- Physical damage
- Exposure to high ambient temperatures
- Internal short circuits

LITHIUM-ION THERMAL RUNAWAY

IN AN OXYGEN-ENRICHED ENVIRONMENT



OXYGEN-ENRICHED ENVIRONMENT



a thermal runaway can ignite materials

- eliminate ignition sources
- fire-resistant barriers
- fire suppression

Examples of Lithium Battery Fires >

Firechief® Global



0:07 / 3:52

Examples of Phone Fires >



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<https://lithiumbatteryrange.firechiefglobal.com/>

More videos

Tap or swipe up to see all



LITHIUM –ION THERMAL RUNAWAY

- The overheating of lithium-ion batteries in cell phones and other electronic devices can be caused by several interconnected factors, including:
- 1. **Internal Short Circuits:** Manufacturing defects or physical damage can create internal short circuits within the battery, leading to rapid heat generation.
- 2. **Ambient Temperature:** High external temperatures can impair the battery's ability to dissipate heat, contributing to overheating during normal operation or charging.
- 3. **Overcharging:** Charging a battery beyond its designated voltage can lead to excessive heat. Modern phones usually have protection circuits, but malfunctioning chargers or cables can bypass these safeguards.
- 4. **Fast Charging:** Technologies that enable rapid charging typically increase the current flow, generating more heat. If the device is not adequately designed to handle this heat, overheating can occur.
- 5. **High Discharge Rates:** Intensive tasks such as gaming, video streaming, or using resource-heavy applications can cause a significant increase in current draw, leading to overheating.

LITHIUM –ION THERMAL RUNAWAY CONTINUED

- 6. **Poor Ventilation:** If a phone is used in a way that obstructs heat dissipation, such as being placed on a soft surface that traps heat, this can lead to overheating.
- 7. **Battery Age and Degradation:** As batteries age, their internal resistance increases, leading to more heat generation during charging and discharging cycles. An older battery may be more prone to overheating.
- 8. **Poor Quality Components:** Substandard materials or construction can lead to inefficiencies and failures that contribute to overheating.
- 9. **Temperature Effects During Use:** Factors like running multiple applications simultaneously, prolonged use in high-performance mode, or even exposure to direct sunlight can raise the device's temperature.
- 10. **Software Issues:** Bugs or poorly optimized software can cause excessive CPU usage, which may, in turn, lead to increased heat production in the battery and device.

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- **It is the most dangerous failure mode of these batteries and a leading cause of fires in medical, aviation, and consumer applications—especially in oxygen-enriched environments.**

HOW STATIC ELECTRICITY IS GENERATED IN HBOT

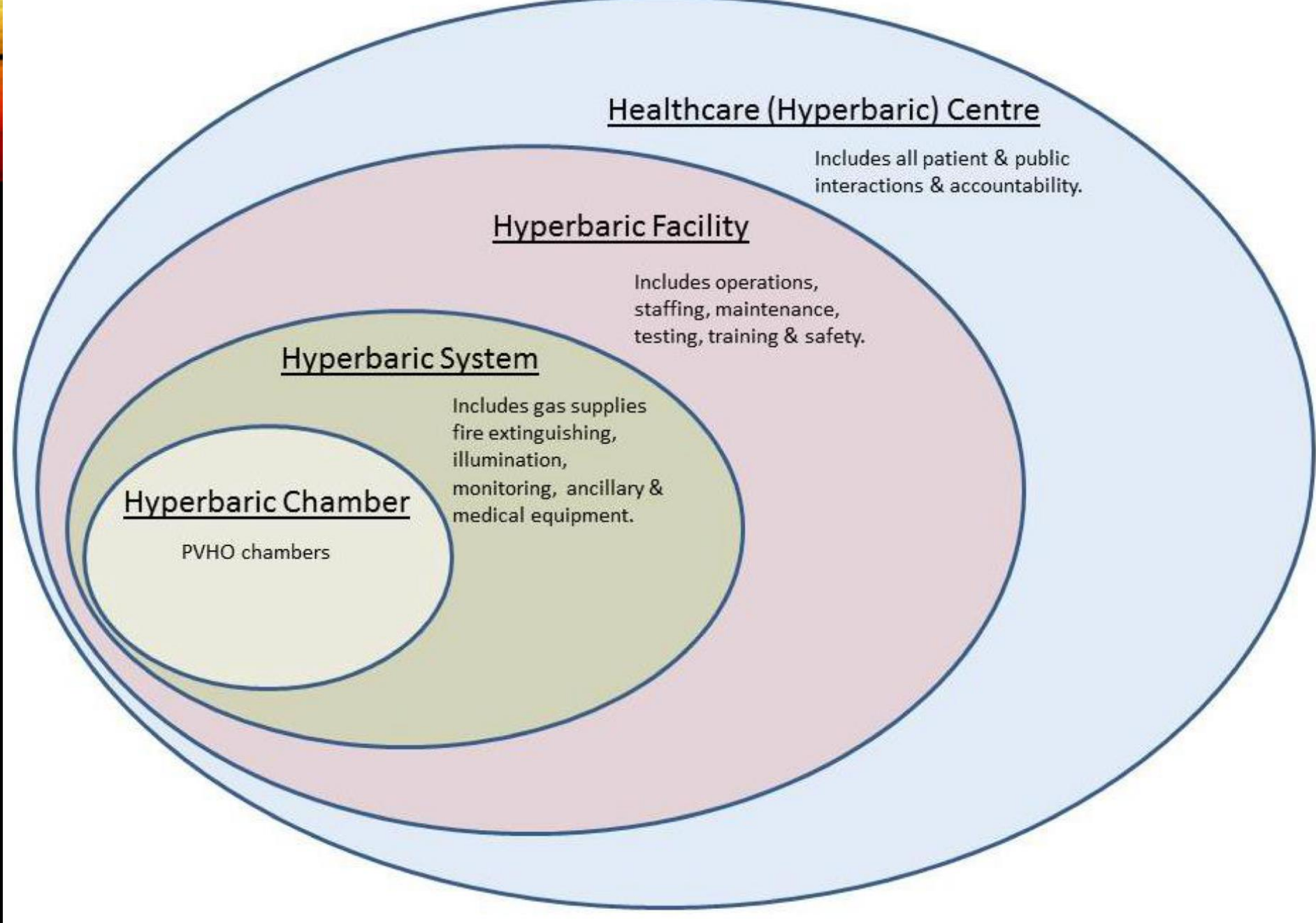
- Friction between synthetic materials (e.g., clothing, sheets, blankets, pillows and padding).
- Movement of patient or operator across non-conductive surfaces.
- Low humidity environments increase static discharge potential.
- Presence of non-grounded equipment or accessories in the chamber.

THE SAFETY PERSPECTIVE

Cause	Deaths/yr
Preventable Hospital Mistakes	250,000
Drug Overdoses	80,400
Suicides	49,300
Gun Violence	46,700
Falls	44,000
Car Accidents	42,500
Drownings	4,000
Food Poisoning	931
Carbon Monoxide Poisoning	400
Airplane Accidents	327
Sports Injuries	100-150
Lightning strikes	20
Golf(Ball strike, lightning, stroke)	4-5
Hyperbaric oxygen therapy	2 in 10 years

STATIC SUPPRESSION AND MITIGATING ELECTROSTATIC DISCHARGE (ESD)

- To mitigate such risks in hyperbaric treatment:
 - Protocols regarding and limiting the use of materials entering the chamber
 - Clothing, linens, blankets and pillows
 - Electronic devices with unsealed batteries
 - Grounding of chamber and patients
 - Limiting the movement of patients under treatment
 - Ensuring the cleanliness of the chamber and items entering the chamber- role of dust in establishing a conductive path



Structuring a Therapeutic Hyperbaric Service

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IMPROVEMENT IN PATIENT CARE & OUTCOMES

Healthcare centre

Accreditation including certification of health care & peer review
Various & ISO 9001 (JCI/JCAHO)
Includes all patient & public interfaces
Ensures quality of healthcare (treatments & outcomes)

Hyperbaric facility

Facility accreditation including certification of operations
ECGP, ECHM (UHMS accreditation)
Includes operations, staffing, maintenance, testing, training & safety
Ensures quality of services & safety of facility

Hyperbaric system

Certification: medical device(s) (MDD)
EN 14931, EN ISO 14971 (FDA, PVHO-1)
Includes gas supplies, fire extinguishing, illumination, monitoring, medical & ancillary equipment.
Ensures quality of equipment (effective, reliable & safe)

Hyperbaric chamber

Certification: pressure vessel (PED)
EN 13445 (ASME VIII) as a PVHO
Ensures pressure vessel safety

↑
PROCESS
↓
↑
STRUCTURE
↓

INCREASE IN EFFORT: TIME, INVESTMENT, RESOURCES & COST →

