



Cryogenic Liquids Safety

Introduction

Cryogenic liquids are liquefied gases kept in their liquid state at very low temperatures. These liquids have boiling points below -238°F (-150°C) and are gases at normal temperatures and pressures. All cryogenic liquids share two critical properties: they are extremely cold, and small amounts of liquid can expand into very large volumes of gas.

Most cryogenic liquids and the gases they produce fall into three categories: inert gases (do not react chemically, do not burn or support combustion); flammable gases (produce a gas that can burn in air when ignited); and oxygen (reacts explosively with organic materials and supports combustion). Common cryogenics by type are listed below.

- **Inert gases:** Argon (Ar), Helium (He), Nitrogen (N₂)
- **Flammable gases:** Hydrogen (H₂), Methane (CH₄), Carbon Monoxide (CO)
- **Oxidizing gases:** Oxygen (O₂), Nitrous Oxide N₂O — reacts explosively with organic materials; supports combustion

Cryogen	Type of gas
Argon (Ar)	Inert
Helium (He)	Inert
Hydrogen gas (H ₂)	Flammable
Nitrogen gas (N ₂)	Inert
Oxygen (O ₂)	Oxygen
Methane (CH ₄)	Flammable
Carbon Monoxide (CO)	Flammable

Hazards

Cryogenic liquids present multiple serious hazards and must not be used without appropriate training, PPE, and engineering controls. EH&S does not authorize use in confined spaces, in the absence of pressure-relief devices, or where adequate ventilation cannot be ensured.

Specific hazards associated with cryogenic liquids include:

- **Extreme Cold:** Cryogenic liquids and cold vapors cause effects similar to thermal burns. Brief exposures can damage delicate tissues (e.g., eyes); prolonged skin exposure causes cold burns and frostbite.
- **Asphyxiation:** Cryogenic gases are very cold, heavier than air, and displace oxygen even if non-toxic. Oxygen-deficient atmospheres (below 19.5% O₂ per OSHA 29 CFR 1910.146) can cause death; this hazard is critical in confined spaces.
- **Flammability/Explosion:** Flammable cryogenics (hydrogen, methane, carbon monoxide) can burn or explode when exposed to ignition sources. Oxygen accelerates combustion and reacts explosively with organic materials.
- **Pressure Hazard:** Without adequate venting or pressure-relief devices, pressure buildup can cause container rupture or explosion.
- **Material Adhesion/Embrittlement:** Plastic, carbon steel, and rubber can become brittle and fail at cryogenic temperatures. Use only materials rated for cryogenic service.
- **Toxicity:** Individual cryogenics may cause specific health effects. Consult the applicable SDS for toxicological information before use.



Use Requirements/PPE

Personal Protective Equipment (PPE)

- **Eye and Face Protection:** Full-face shield and splash-resistant goggles provide the best protection. Safety glasses alone are not adequate. Contact lenses should not be worn when handling cryogenics.
- **Hand Protection:** Insulated or leather cryogen gloves are required. Rubber gloves must not be used (they can harden instantly). Remove metal jewelry and watches before handling.

- **Clothing and Footwear:** Closed-toe shoes and long-sleeved shirts are required. Do not allow any unprotected body part to contact uninsulated pipes or vessels containing cryogenic fluids.

Safe Handling

- All cryogenic systems must be equipped with pressure-relief devices. Never operate a system that lacks a functioning pressure-relief device.
- Conduct all operations involving cryogens in well-ventilated areas to prevent gas or vapor accumulation. Do not perform operations in confined spaces.
- Ensure all equipment and containers are free of oil, grease, dirt, and other contaminants that could create a flammability or reactivity hazard.
- Do not drop, tip, or roll containers on their sides. Always use proper connections; never remove or interchange fittings.



Storage

- Store cryogens in a well-ventilated area to prevent oxygen deficiency. Do not store in confined spaces, basements, or sealed rooms.
- Avoid contact of moisture with storage containers to prevent ice plugs in relief devices.
- Store in upright position; do not store on carts or shelves where containers could fall or be knocked over. Keep all heat sources away from cryogenic storage.
- Do not store cryogenic liquids with corrosive or flammable liquids. Orient storage unit vents and openings away from personnel and equipment.

Transfer Operations

- Use only fitted transfer tubes designed for the specific container. Do not fill secondary containers beyond 80% capacity (60% when ambient temperature is likely to exceed 30°C).
- Conduct transfer operations from open cryogenic containers (e.g., dewars) slowly to minimize boiling and splashing. Transfers from open containers must occur below chest level.
- Use a suitable hand truck for container movement. If cryogens must be transported by elevator, ensure no passengers share the elevator during transport.

Standard Operating Procedures (SOPs)

Laboratory- or process-specific SOPs must be developed for each cryogen application and reviewed annually or after any incident. SOPs must address:

- Proper PPE selection, use, and limitations; including donning and doffing procedures for cryogenic gloves and face shields
- Safe filling, transfer, storage, and disposal procedures specific to each cryogen and container type
- Emergency response and spill procedures for each cryogen

Emergency Procedures

Cryogenic spills can rapidly produce large volumes of cold, oxygen-displacing or flammable gas and pose immediate risk of freeze burns, asphyxiation, or fire/explosion. All spills must be treated as emergencies. Do not re-enter a spill area until cleared by emergency responders or EH&S.

1. **Evacuate immediately.** Exit the spill area at once. Alert others in the area. Do not attempt to clean up or contain the spill.
2. **Contact emergency personnel.** Call 911 and OSU EH&S (541-737-2273). Report the cryogen involved, quantity, and location.
3. **Address pressure relief failure.** If a pressure relief valve fails and allows improper or continuous venting, safely move the container to a well-ventilated area if it can be done without risk of exposure, post a warning sign, and contact the manufacturer/distributor. Do not attempt to repair the relief device.
 - **Skin/eye contact — First Aid:** Flush the affected area with cool or lukewarm water (not cold, not hot, and not above 40°C) for a minimum of 15 minutes. Do not rub the affected area as this can cause additional tissue damage. Do not apply dry heat. Seek immediate medical attention. For eye exposure, irrigate continuously and seek emergency medical care.

- **Re-warming:** Re-warming of frostbitten tissue must be done gradually under medical supervision. Do not attempt rapid re-warming in the field. Call 911 and transport to medical care.

Disposal

Unwanted cryogenics should be eliminated by use, or evaporation in secure well-ventilated areas. For a damaged container or full container that needs immediate removal contact EH&S.

The following practices are prohibited:

- Pouring cryogenic liquids down the drain
- Allowing cryogenics to vaporize in a cold room, refrigerator, sealed room, or basement as a means of disposal

Regulations/References

The following regulations and standards apply to the use, storage, and handling of cryogenic liquids at Oregon State University:

OSHA 29 CFR 1910 Subpart H — Hazardous Materials (Compressed Gases)

- 29 CFR 1910.101 — General requirements for compressed gas cylinders, including inspection and safe use requirements applicable to cryogenic containers.

OSHA 29 CFR 1910.132–138 — Personal Protective Equipment

- Establishes requirements for employer-provided PPE, hazard assessment, and employee training applicable to cryogenic operations.

NFPA 55 — Compressed Gases and Cryogenic Fluids Code

- Establishes requirements for storage, use, and handling of compressed gases and cryogenic fluids, including quantity limits, ventilation, and container siting requirements.
- Industry standard guidance document for safe cryogenic liquid handling, referenced by OSHA and widely used as a basis for institutional safety programs.