Cryogenic Liquid Policy

Contents

Purpose 2
Scope 2
Definitions 2
Responsibilities 2
Hazards Associated with Cryogens and Dry Ice 2
Personnel Protective Equipment (PPE) 4
Special Handling Procedures 4
Special Precautions for the Use of Cryotubes 4
Storage and Transportation 5
  Transport of Cryogens Within and Between Buildings 5
  Vehicle Transport of Cryogens 6
Emergency Procedures 6
In the Event of Contact with Cryogenic Gases or Liquid 6

Purpose

Working with Cryogenic liquids involves significant health and safety hazards. This policy identifies health hazards, safe work methods, safe handling, transport, storage, and emergency spill response information to assist personnel with reducing the risk of working with cryogenic liquids. Cryogenic liquids or cryogens are refrigerated, liquefied gases having a boiling point colder than -130°F at a pressure of one atmosphere absolute. Examples of cryogenic liquids include Oxygen, Nitrogen, Argon Neon, Krypton, Xenon, Hydrogen, Helium, liquefied natural gas (LNG)/methane, and Carbon Dioxide (solid cryogen or dry ice).

Scope

All University of Arkansas personnel who use cryogenic liquids.

Definitions

Cryogenic liquid: Liquid with normal boiling point below -130°F.

Cryotubes: Plastic biological sample tubes able to stand very low temperatures.

Dewars: Liquid dewar flasks are non-pressurized, vacuum-jacketed vessels, similar to a Thermos bottle. Dewars are designed with either loose-fitting caps or pressure relief valves, that prevent air and moisture from entering, yet allows excess pressure to vent.

Dry Ice: Dry ice is the solid form of carbon dioxide, non-combustible, available in flakes, pellets, or block form. Dry ice will vaporize directly to the gas state at a temperature of -78.5°C (109.3°F) or higher.

Responsibilities

Environmental Health and Safety (EN&S) shall

- Provide technical assistance when needed.

Principal Investigators (PI's)/Supervisors shall

- Ensure that employees understand the contents of this policy, are instructed on the means of implementation, and are provided with proper equipment and controls.
- Ensure that appropriate personal equipment (PPE) is supplied and maintained.

Personnel shall

- Handle cryogenic liquids only if properly trained.
- Review hazard information detailed on SDS sheets before working with cryogens.

Hazards Associated with Cryogens and Dry Ice

Consider the following hazards during the handling, transportation and storage of cryogens and dry ice.

- **Burns and Frostbite:** Skin contact with a cryogen, dry ice or non-insulated equipment parts can cause cold burn and frostbite. Eye contact with a cryogen or dry ice can cause permanent eye damage. Always wear the proper PPE when working with or around cryogens or dry ice.
- **Asphyxiation:** When cryogenic liquids form a gas, the gas is very cold and usually heavier than air. Small amounts of liquid can evaporate into very large volumes of gas. This gas can accumulate near the floor and displace air, resulting in the threat of asphyxiation. The potential for oxygen deficiency is an especially serious hazard in enclosed or confined spaces.
- **Fire and Explosion Hazards:** Liquid Nitrogen and Helium are not flammable. However, they can condense oxygen out of the air by evaporation creating an oxygen-rich environment. Flammable materials can ignite in the presence of condensed oxygen.
- **Over-pressurization Hazards:** Cryogenic systems must be equipped with pressure-relief devices that must be kept clear of blockages.
- **Dewars:** These devices have an insulating vacuum space in between their double walls. If a dewar becomes damaged, air or liquid can leak into this vacuum space. This will reduce its insulating storage vessel properties and can greatly increase the pressure inside the dewar. Dewars and storage vessels are equipped with pressure-relief devices that prevent high pressure from developing (liquid Nitrogen Dewars have one valve and one bursting disc, liquid Helium have two valves and one disc, and dewar flasks are equipped with loose-fitting lids or specially vented stoppers). Air or liquid that leaks into a vacuum space can freeze. If the space is rapidly warmed after starting a transfer, the pressure-relief valve will vent the gas that is generated, preventing an explosion. **Never** cover a pressure relief valve that is venting.
- **Nuclear Magnetic Resonance (NMR) or Magnetic Resonance Imaging (MRI)**. These instruments have superconducting components that are cooled to reach the superconducting temperature by large reservoirs of cryogenic liquid. A major problem can arise when the cryogenic liquid begins to lose volume and to expose the top wires above the level of the liquid. The wire that is exposed above the cryogenic fluid becomes hotter, loses superconductivity, and begins to be heated by Joule heating: the heat generated by electrical resistance in regular materials that do not superconduct. This heat begins to drive off any remaining cryogenic liquid by vaporizing the liquid. The instrument that is experiencing this issue will vent large quantities of gas in the process, which will be (1) cold and (2) possibly displace breathable air unless the system is vented to the outside, so a proper evacuation program for the area should be developed, trained, and enforced. The Society of Radiographers recommends a low oxygen alarms in the room, since there is often very little warning when accidental quenches occur with venting.

Personnel Protective Equipment (PPE)

First, you must perform a Hazard Assessment to determine appropriate PPE when working with cryogenic liquids. Potential PPE for use when filling dewars or when removing specimen or samples from a dewar include:

- Cryo-gloves
- Face shield
- Safety Goggles/Shield
- Lab coat
- Long pants

The following should be worn when handling dry ice:

- Cryo-gloves
- Lab coat
- Long pants

Special Handling Procedures

- Always work with cryogens and dry ice in well ventilated spaces, especially when filling dewars. Adequate ventilation is essential since a small amount of liquid can rapidly convert to a large volume of gas that can displace air.
- Remove metal jewelry on your hands and wrists before working with cryogens. If exposed to cryogenic liquids or boil-off gases, jewelry can freeze to the skin.
- Cryogenic containers are designed and made of materials that can withstand rapid change and extreme temperature differences encountered in working with cryogenics. However, fill containers slowly to minimize internal stresses.
- If feasible, use chemical fume hoods when working with cryogens.
- Never allow any unprotected part of the body to touch exposed pipes/vessels containing cryogenic liquids; any skin coming in contact with the cold metal may adhere to it and tear when attempting to withdraw. Wear long sleeves shirt and pants.
- Exercise caution when adding a cryogenic liquid to a dewar at room temperature or when adding an object at room temperature to a cryogenic liquid. Both will cause the liquid to boil and splash vigorously.
- Always employ a retrieval device or tongs to recover items submerged in liquid nitrogen. Cryo gloves do not protect against liquid nitrogen penetration, only against exposure to cold surfaces.
- Periodically inspect equipment and remove ice and frost blockages from openings to prevent over pressurization.

Special Precautions for the Use of Cryotubes

- Cryotubes containing samples stored under liquid Nitrogen may explode without warning. Tube explosion are caused by liquid Nitrogen entering the tube through

minute cracks and then expanding rapidly as the tube thaws after remove from dewar.

- Cryotubes are designed for vapor phase storage in the extreme cold Nitrogen gas that sits just above the reservoir of liquid Nitrogen in the bottom of the freezer or dewar. If the freezer/dewar is overfilled with liquid Nitrogen and the vials are immersed, leakage of liquid Nitrogen into the vials occurs. To avoid this problem, do not overfill the freezer/dewar with liquid Nitrogen and visually check each cryotube prior to filling to ensure there are no defects around the rim.
- PPE for thawing cryotubes should include safety glasses/face shield, insulated heavy Cryo gloves, a buttoned lab coat, closed toed shoes and pants.
- As a precaution, slowly remove vials from the dewar, holding the vial in the neck of the dewar for a moment before bringing them into room atmosphere. A tube that is going to explode will usually do so early in the warm-up process.
- Keep cryotubes in a heavy, walled container or behind a safety shield while warming.
- Cryotubes should never be reused.

Storage and Transportation

- Never store cryogenic liquids in walk-in cold rooms as they are confined spaces.
- Avoid all contact of moisture with cryogenic materials as a small amount of moisture freezing across the opening of a dewar flask or its safety relief valve could cause a pressure buildup and potential explosion. The cloudy vapor that appears when a liquefied cryogenic gas is exposed to the air is condensed moisture, not the gas itself.
- Caution must be observed when lowering objects or experiments into a dewar flask or cryogenic liquid to prevent an object from freezing tight in the neck of the flask. The obstruction of the dewar flask opening will cause excessive dangerous buildup of internal pressure in the flask and could potentially rupture the vessel.
- Never handle or carry dewar flasks by the neck, as the neck is the main support for the inner liner of the container. Always use the handles provided on the container.
- All cryogenic liquid vessels must be stored in a secure location to prevent access by untrained personnel.
- No smoking, open flame, or spark-producing equipment is permitted in an area where flammable cryogenic liquids are loaded/unloaded, stored, handled or used.

Transport of Cryogens Within and Between Buildings

- No fewer than two trained individuals should transport cryogenic liquids using dewar flasks secured on carts, or handcarts equipped with brakes for large dewar flasks and cylinders.

- **NEVER** transport an open container of cryogenic liquid regardless of size or volume.
- Plan your route of transport. If using an elevator is necessary, send a second person to the receiving floor while you send the dewar flask to the receiving floor unmanned. You should never ride in elevator car with a dewar as a release/spill inside the elevator car may quickly cause oxygen displacement.
- When carrying a small dewar flask make sure it is the only item you are carrying. Hold the dewar flask as far away from your face as possible. Be on lookout for other people who may accidently run into you or bump you.
- You should never transport dewar flasks between buildings. The chance of an accident, which could cause rupture of dewar flask, is too great.

Vehicle Transport of Cryogens

- **NEVER** take liquid nitrogen or other cryogenic liquids in a car or van where the driver's compartment is not segregated and sealed from the load. When a specimen needs to be transported frozen consider using dry ice, which would be suitable since it reduces risk.
- Transportation of cryogenic liquids shall not be done in a personal vehicle. It must be coordinated and performed with assistance from Environmental Health and Safety per 49 CFR 173 Federal DOT Regulations.

Emergency Procedures

- If any spill occurs ***IMMEDIATELY EVACUATE,*** the area. Call 911 for spills of Cryogenic Liquids and the Fire Department will monitor oxygen atmosphere to determine when it is safe to return to the building
- If experiencing any symptoms such as lightheadedness, dizziness, or confusion, immediately seek fresh air and medical attention.
- If an individual becomes unconscious in a cryogenic liquid area, contact 911 immediately and let Fire Department retrieve personnel involved. Over half of deaths associated with asphyxiation in confined spaces involve would-be rescuers.

In the Event of Contact with Cryogenic Gases or Liquid

- Immediately remove any clothing that has been contaminated. In the event of clothing contamination with Oxygen, Hydrogen, or Carbon Monoxide it is important to remove clothing, evacuate personnel from the facility, and keep away from ignition sources.
- Flush or soak the area with warm water no greater than 105°F.
- Do not apply dry heat or rub damaged flesh or eyes.
- Employees should notify their supervisor of injuries, seek medical attention, and use this link to fill out the Accident, Incident, or Unsafe Condition Report.