Laboratory Safety Bulletin

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Location: Essex Hall / B-37 • Hours: 8:30 am to 4:30 pm (M-F)

Handling and Transport of Cryogenic Liquids

Definitions

Cryogenic liquids (or cryogens) are liquefied gases that are cooled below room temperature–most cryogenic liquids are below -150°C; examples include: liquid nitrogen, helium and dry ice. Slush mixtures of dry ice, frozen carbon dioxide, and isopropanol or acetone which have slightly higher boiling points are sometimes included in this category.

Dry Ice - frozen carbon dioxide. Dry ice sublimates from a solid to a gas at room temperature.

Cryogenic liquid containers are used for holding cryogens. These containers operate at pressures up to 350 psig and have capacities between 80 and 450 liters of liquid. Mainly 200 liters are used at the University of Windsor. They contain a large volume of gas at a relatively low pressure compared to a compressed gas cylinder and provide a source of cryogenic liquids which can be easily handled. Product may be withdrawn as a gas by passing liquid through an internal vaporizer or as a liquid under its own vapor pressure.
Dewars are no pressurized vessels for holding cryogenic liquids. They are available in variety of shapes and sizes.

Pressure-relief devices: All cryogenic containers vent to atmosphere to prevent hazardous pressure buildup inside the container. These devices may be: (1) valves which open to relieve pressure, (2) bursting discs that break to relieve pressure and must be replaced; or (3) loose-fitting lids on Dewar flasks.

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Personal Protective Equipment

Personal Protective Equipment (PPE) should always be worn when handling cryogens.

- Suitable thermal gloves
- Face shield - when working with large volume of cryogen.
- Safety goggles
- Lab coat
- Long pants
- Closed toed shoes - most sport shoes are porous and could result in cold burns if the cryogen penetrates the covering and enters the shoe.

Hazards Associated with Cryogens and Safety Precautions

HAZARD	CHARACTERISTICS	SAFETY PRECAUTIONS
COLD BURNS	Cryogenic liquids and their cold vapours can produce effects on the skin like a thermal burn. Brief exposures that would not affect skin on the face or hands but can damage delicate tissues such as the eyes. Prolonged exposure of the skin or contact with cold surfaces can cause frostbite or severe cold burns. Prolonged breathing of extremely cold air may damage the lungs.	Avoid skin and eye contact with cryogenic liquids. Wear appropriate PPE. Do not inhale cryogenic vapors. Handle objects that are in contact with cryogenic liquids with tongs or proper cryogenic gloves. Remove all metal jewelry from wrists and hands (a spill/splash could freeze the jewelry to your skin) when handling cryogenic liquid.
OXYGEN DEFICIENCY/AS-PHYXIATION	Both cryogenic liquids and dry ice undergo substantial volume expansion when converted to a gas phase. For example, 1L of liquid nitrogen forms nearly 700L of nitrogen gas at room temperature which can potentially lead to an oxygen deficient atmosphere where ventilation is limited. Oxygen deficiency creates an asphyxiation hazard. The use of dry ice in cold rooms can cause increased breathing, headache, dizziness, nausea and visual disturbances due to elevated carbon dioxide concentrations in the air. Dry ice can also cause asphyxiation in confined spaces.	Only work with cryogenic liquids in **well-ventilated areas** to avoid localized oxygen depletion or buildup of flammable or toxic gas if handling hazardous cryogens. Do not enter an oxygen deficient atmosphere even to rescue someone. ***Note: You cannot detect oxygen deficiency or over exposure to carbon dioxide.***
PRESSURE BUILD-UP	Liquid Nitrogen boils off very quickly. Pressure can quickly build up in a sealed unit with risk of explosion. Sudden release of this pressure can cause personal injury by issuing cold gas or liquid, or by expelling parts, because of bursts.	Do not put liquid nitrogen in closed vessels that cannot withstand the pressure. Use only the stopper supplied with the Dewar. Inadequate venting can result in excessive gas pressure, which can damage or burst a container. Cryogenic systems must be equipped with pressure-relief devices.
CONDENSATION OF ATMOSPHERIC OXYGEN	Liquid nitrogen can condense oxygen from the atmosphere and in some cases cause oxygen to accumulate as an unwanted contaminant. For example, if a constant stream of air is pulled through a vacuum trap cooled with liquid nitrogen, liquid oxygen may condense in the trap. Similar oxygen enrichment may occur where condensed air accumulates on the exterior of cryogenic piping. Violent reactions such as rapid combustion or explosion may occur if any kind of combustible material contacts this oxygen. Liquid oxygen reacts violently with most organic substances, including Teflon tape, vacuum grease, and organic solvents.	When liquid cryogens or dry ice are used to cool traps attached to vacuum pumps, these traps must be emptied immediately after use. Never leave cold traps immersed in the cryogen. Only people trained on the use of a vacuum line should use cryogens for cooling cold fingers or traps.

HAZARD	CHARACTERISTICS	SAFETY PRECAUTIONS
BOILING/SPLASHING OF LOQUID NITROGEN	Rapid boiling or splashing of liquid nitrogen occurs when filling a container at room temperature or when inserting objects into the liquid. ***Note:*** *The cloudy vapor that appears when liquid nitrogen is exposed to the air is condensed atmospheric moisture. The gas itself is invisible*	Transfers or pouring of cryogenic liquids and immersing equipment at ambient temperature into the liquid cryogens should be done very slowly to avoid splashing. Use tongs to withdraw objects immersed in the liquid and take care where both tongs and object are then placed.

Transportation of Cryogens on Campus

Small Volumes

Inside buildings, from room to room, the best method to transport of liquid nitrogen (4 L and less) is to use a small Dewar which has carrying handles and a loose-fitting lid or vent. This will allow the gas produced from the liquid boiling off at room temperature to escape. If using a thermos flask, do not screw the lid on so that evaporating gas may escape safely. Never transport an open container of cryogenic liquid, no matter how small. These dewar can be carried by hand. **Never pull, push or roll a dewar and wear appropriate PPE** such as lab coats, face mask and insulated gloves.

Larger Volumes

Larger volumes of liquid nitrogen should be transported in containers that are secured either to a stable trolley or on wheels. Lifting and carrying full liquid nitrogen containers >25 liter is a two-person task and should not be carried out alone. Dewars are heavy and can crush your foot if it runs over you. For transport of large cryogenic liquid containers outside, over pavers and walkways a specialized trolley should be used. Stay completely clear of grates, large cracks, and/or uneven portions of the pavement, and any other hazards which could catch a wheel and cause tipping.

Use of Elevators in the Transport of Cryogens

Always use a freight elevator or lift to transport cryogen liquids. **Never accompany a transport dewar in an elevator or lift.** The cryogen must travel unaccompanied. An elevator is a confined space, and should leakage occur the **asphyxiation** is possible. It is recommended that two people work together to transport containers of liquid nitrogen via elevator. One person should place dewar in the elevator while other waits to receive the dewar from the elevator when the journey is complete.

Handling of Cryogenic Liquids

- Always handle cryogenic liquids carefully wearing appropriate PPE. Boiling and splashing will always occur when filling a warm container.
- While dispensing cryogenic liquid from a dewar the laboratory door MUST be kept FULLY OPEN and persons filling must be in constant attendance to the filling operation.
- Do not hold the vessel with unprotected hands while filling. Cryogenic liquid is to be dispensed only into smaller containers which have carrying handles.
- Do not allow a cryogenic liquid to fall through a distance to reach the receiving vessel. Never overfill containers. Spillage damages flooring and could cause injury.
- Use only the stopper supplied with the dewar. Inadequate venting can result in excessive gas pressure, which can damage or burst a container.
- Never plug small containers of cryogenic liquid; cover them loosely when not in use to prevent accumulation of moisture and formation of ice.
- Never dispose of cryogenic liquids in a confined area or pour it down the sink.

- Beware of liquid splashing and rapid flash off cryogens when immersing equipment at ambient temperature into the liquid cryogens. This operation must be carried out very slowly.
- Use only metal or Teflon tubing connected by flexible metal or Teflon hose for transferring liquid cryogens.
- Do not use tygon or plastic tubing. They may split or shatter when cooled by the liquid flowing through it and could cause injury to personnel.
- Some instrumentation or laboratories may have local rules for the use of cryogens which must be followed (e.g. NMR lab).

Spills

Minor spill (< 1 liter) - allow liquid to evaporate, ensuring adequate ventilation. Following return to room temperature, inspect area where spillage has occurred. If there is any damage to the floors, benches or walls, report it to the supervisor/Facilities.

Major release (> 1 liter) - shut off all sources of ignition, evacuate area of all personnel and call the Campus Police by dialing 911 from a campus phone for emergency assistance. **DO NOT** return to the area until it has been declared safe.

Waste Disposal

- Allow nontoxic cryogenic liquids such as nitrogen, argon, helium etc., to evaporate in a well vented location remote from work areas.
- Do not store cryogenic substances or allow them to vaporize in enclosed areas, including: fridges, cold rooms, sealed rooms and basements.
- Do not dispose cryogenic liquids down the sink - they will crack waste pipes causing potentially dangerous leaks.

First Aid

- If skin or eyes comes in contact with a cryogenic liquid, run the area of skin under cool or warm water for fifteen minutes (do not use hot or cold water). DO NOT RUB OR MASSAGE AFFECTED AREAS - this can cause further tissue damage. Refer to the MSDS for any specific instructions. Where medical attention is required, ensure to bring along MSDS(s) of cryogenic liquid to aid medical staff in proper diagnosis and treatment.

- People suffering from lack of oxygen (asphyxia) should be moved to fresh air. Asphyxia can be characterized by the following symptoms: rapid and gasping breath, rapid fatigue, nausea, vomiting collapse or inability to move, unusual behavior. If you suspect that someone is suffering from asphyxiation, do not enter the affected area alone first call for help. Call Campus Police by dialing 911 from a campus phone. Remove the victim to the fresh air. If the victim is not breathing, administer artificial respiration. If breathing is difficult, trained emergency response personnel can administer oxygen. Obtain immediate medical attention.
  However, if the victim is in a confined space do not rescue affected person. In confined spaces or where oxygen deficient atmospheres may be present rescue should only be made by those trained in the use of breathing apparatus and confined space entry procedures.

- If the eyes are exposed to the extreme cold of the liquid nitrogen or its vapors, immediately warm the frostbite area with warm water not exceeding 40°C and seek immediate medical attention.

References:

1. http://www.uow.edu.au/content/groups/public/@web/@sci/@chem/documents/doc/uow016882.pdf
2. http://www.tlchm.bris.ac.uk/safety/lnitcry.htm