FactSheet Cryogens & Dry Ice

Cryogens are substances used to obtain very low temperatures and are extensively employed in teaching and research at USC. Dry ice (solid carbon dioxide), though not categorized as a cryogen, is also frequently used at USC for low temperature applications. It sublimes directly to a gas at −78.5°C.

There are potential health hazards common to both cryogens and dry ice that include asphyxiation, frostbite, and injury from sudden expansion/explosion.

What are the uses of cryogens and dry ice at USC?

- Liquid nitrogen (LN_2; bp: −196°C) - Cold trap/distillation; tissue preparation; LN_2 freezers; research.
- Liquid helium (bp: −269°C) - Superconducting magnet cooling/NMR machine; ultra low temperature research.
- Dry ice - Alcohol or acetone cold bath to increase the rate of heat transfer; tissue preparation; research.

What are the hazards?

Cryogenic liquids expand 700 to 900 times their volume upon evaporation/ boiling. This can cause:

- *Explosion*. A cryogenic liquid (or dry ice) in a closed vessel will produce an irresistible rise of pressure on warming, usually causing the vessel to burst explosively.
- *Asphyxiation*. The boil-off gas may displace sufficient air to cause a hazardous, or even lethal, reduced-oxygen atmosphere.

The extreme cold of cryogenic liquids may cause:

- *Cold Burns (frostbite).* A painful condition caused by damage or death of frozen tissue. Extreme cases can result in loss of fingers or toes.
- *Oxygen/Air Condensation*
  - Liquid helium is cold enough to freeze air into a solid. Always follow manufacturer's operating instructions and safety precautions with liquid helium equipment to minimize the risk of vents becoming hazardously plugged with frozen air.
  - LN_2-cooled surfaces (e.g., metal filling hose, a trap on a Schlenk line) may condense oxygen-enriched air. The liquid is easily recognized since all other likely substances freeze at that temperature.

Liquefied air presents a fire or explosion hazard if it contacts combustible materials in the presence of an ignition source. If liquid air is present or suspected:

1. Open the system wide to the atmosphere.
2. Remove the cooling bath.
3. Allow to evaporate. Liquid air that boils in a closed or narrowly-vented system will cause extreme pressurization and may result in an explosion.

Carbon dioxide (CO_2) is both an asphyxiant and actively toxic at high concentrations.[1] At room temperature, it is denser than air and even more so when cold.

Bulk dry ice is stored in large, top-opening containers (chests) around campus that fill to the top with CO_2 gas. Do NOT place head into container when reaching for last blocks of dry ice.

Inhalation of CO_2 in high concentration may lead to headache, nausea, tremors, and suffocation. Consult the SDS for more information.

What I need to know...

- NEVER store liquid nitrogen or dry ice in cold rooms. Cold rooms are non-ventilated.
- For uncontrolled release of LN_2, evacuate area immediately. Close doors behind last person to exit. Contact DPS at (213) 740-4321.
- NEVER immerse hands in LN_2, even with cryogenic gloves. This will result in **SEVERE** injury!
- Only use vials and glassware designed and approved for cryogenic work.
- Remove all metal jewelry from wrists and hands. A spill/splash may freeze the jewelry to the skin.
- Contact labsafety@usc.edu for more information.

1 Asphyxiation Due to Dry Ice in a Walk-in Freezer

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What are the storage requirements for cryogens and dry ice?

- Store cryogens and dry ice in well-ventilated locations. **NEVER** store liquid nitrogen or dry ice in cold rooms. Cold rooms are non-ventilated.
- Restrain large dewars (e.g., 20 L) and all pressurized dewars (regardless of size) for seismic safety per guidelines in Compressed Gas Cylinder Storage Fact Sheet.
- An oxygen deficiency monitor is recommended for all rooms which contain large quantities of LN_2 and/or dry ice.

- Place appropriate internal and external signage where cyrogens are being used and stored.

What PPE is needed?

- *Hand protection*. Cryogenic gloves - thermally-insulated, loose-fitting gloves to protect against contact with cold surfaces. They are not liquid-tight and DO NOT protect against immersion in liquid nitrogen. Remove immediately if they become soaked. Nitrile gloves may be used if dexterity is needed and cold surfaces are absent.

- *Face protection*. Splash goggles to guard against incidental splashes; face shield is used in combination with splash goggles for higher-hazard operations (e.g., dispensing from a pressurized dewar).

- *Body protection*. Lab coat (100% cotton) and closed-toe/closed-heel/non-absorbent shoes (required). Avoid wearing pants with cuffs since they can retain liquid nitrogen.

What are the steps for filling open-necked (unpressurized) dewars?

- Wear appropriate PPE before filling. Also, ensure that:
  - 160-L LN_2 dewar is in well-ventilated area. 3000-L LN_2 tanks at USC are located outside buildings (e.g., CEM and SSC).
  - Flexible or rigid stainless steel transfer line is attached to liquid port on 160-L dewar.
- If a diffuser is fitted to filling pipe, do NOT remove it.
- Place metal hose directly into recipient dewar. Make sure that dewar is stabilized so that it does not tip over during filling.
- Obey any local filling SOPs
- ***Slowly*** open liquid port valve to initiate flow. A jet of cold vapor will continuously exit the recipient dewar as it fills. REMEMBER: Do not leave dewar unattended.
- Dewar is filled when LN_2 begins to overflow. Turn off valve and remove flex transfer line carefully.
- Remove recipient dewar and transport to lab safely (see below).
- Pressurized dewars are only to be filled by designated experienced personnel.

What is needed to transport cryogens and dry ice?

- Use a wheeled utility cart to transport LN_2 dewars within and between buildings. Place dewars on the bottom shelf. NEVER push, pull, or roll a dewar.
- Do NOT transport LN_2 or dry ice in passenger or service elevators with occupants.
  1. Place dewar/utility cart in empty service elevator. If no service elevator available, use an empty passenger elevator with caution.
  2. Attach a conspicuous "Do Not Enter" sign to dewar/utility cart and send to destination floor.
  3. Direct co-worker to wait at destination floor to receive dewar/utility cart.

REMEMBER: NEVER store or transport cryogens and dry ice in an enclosed vehicle (e.g., passenger car or SUV).

First Aid (OSHA QuickFacts)

- In case of exposure to cryogens or dry ice, remove any clothing that is not frozen to the skin. Do NOT rub frozen body parts because tissue damage may result. Obtain medical assistance as soon as possible.
- Place the affected part of the body in a lukewarm water bath (not above 40°C). Never use dry heat.

References

USC EH&S Cryogenic Liquids SOP

University of Florida EH&S Cryogen Safety

Grainger Catalog Cryogenic gloves

OSHA QuickFacts Laboratory Safety Cryogens and Dry Ice

Northwestern University video
Filling and Maintenance of Liquid Nitrogen Tanks