DEPARTMENT OF
ENVIRONMENTAL SAFETY,
SUSTAINABILITY & RISK

Seneca Building
4716 Pontiac Street, Suite 0103
College Park, MD 20742
301.405.3960 TEL 301.314.9294 FAX

Cryogens & Dry Ice Fact Sheet

This fact sheet is for general safety awareness. Individual Standard Operating Procedures for all experiments and processes involving cryogens or dry ice must be developed by the laboratory.

Cryogens are liquefied gases that are stored and dispensed at extremely low temperatures. All cryogenic liquids are gases at normal temperatures and pressures. When placed under pressure in specially designed storage containers (dewars), the gases condense to a liquid state and maintain very cold temperatures. Dewars can be designed with an operating pressure as high as 350 psig or as low as 22 psig. Various gases can be used as cryogenic liquids. The most common cryogen used at UMD is nitrogen, but helium or argon may be used in some research spaces.

The extreme low temperatures of a cryogen (e.g., liquid nitrogen has a boiling point of -196 °C, -321 °F) can cause immediate burns or frostbite if it comes into contact with unprotected body parts or through clothing. The low temperatures may also cause some materials such as carbon steel, rubber, and plastics to become brittle and shatter/crack. Solid carbon dioxide or dry ice, although not a cryogen, converts directly to carbon dioxide gas at -78 °C, -109 °F, is also often used in laboratories and can possess similar hazards to cryogens.

When leaving a dewar, cryogens change from liquid to gas is accompanied by a large expansion in volume (e.g., liquid nitrogen changing to gas will expand by a factor of 696). This expansion can displace oxygen in a room and lead to asphyxiation due to the resulting oxygen deficient atmosphere that can be created if sufficient gas is released. Less common cryogens such as propane, hydrogen, and oxygen, present risk of fire due to their inherent flammability or oxidizing qualities. Additionally, cryogen cooled surfaces may condense oxygen-enriched air that forms a liquid on the surface. Liquified oxygen can present a fire or explosion hazard if it contacts combustible material and a source of ignition.

CONTROLS

Engineering Controls

- Cryogens or dry ice must be used and stored in a well-ventilated space such as those spaces with single pass ventilation.
- When using large volumes of cryogens, or if cryogens are used in a small or poorly ventilated space, local exhaust ventilation or oxygen monitoring may be necessary. Contact ESSR for more information.

Personal Protective Equipment

- Cryogen protective gloves - should be loose-fitting so they are able to be quickly removed if cryogenic liquid is spilled on them.
- Splash goggles
- Face shield
- Lab coat or chemical resistant apron
- Clothing that leaves no exposed skin on legs or feet, pant legs should not have cuffs and shirt sleeves should not be rolled up
- Closed-toe shoes that fully cover the top of the foot
- Remove all metal jewelry from wrists and hands. A spill/splash could freeze the jewelry to the skin.

Training

- Northwestern University YouTube video:
  Filling and Maintenance of Liquid Nitrogen Tanks
- Laboratory Specific Training must cover all processes using acutely toxic materials and include information on safe use and emergency response.

STORAGE

- Cryogen containers must always be stored upright.
- Store dewars away from heat sources.

- Never store cryogenic liquids or dry ice in a sealed vessel.
- Store flammable or oxidizing cryogenic liquids away from combustible materials and sources of ignition.
- Keep combustible materials and sources of ignition away from surfaces where liquid oxygen could condense.
- Pressurized cryogenic liquids are stored in dewars equipped with safety devices such as pressure relief valves and a rupture disc. As a cryogen dewar leaks heat, it may vent intermittently through the safety relief valve; this is normal. Gas venting continuously through the safety relief valve indicates safety relief valve failure or excessive heat leak. Never tamper with or plug the safety devices and make sure that ice buildup is not blocking the safety devices of the dewar.
- Do not store cryogens in cold rooms. This will not slow down the evaporation rate of the cryogen as temperatures in cold rooms are typically well above the boiling point of cryogens. Cold rooms generally have recirculating ventilation and can quickly become an asphyxiation hazard when cryogens are stored in them.
- Dry ice is typically stored in open top containers. Do not place head in the container as it presents an asphyxiation hazard.

USE

- Before using a cryogen dewar, become familiar with components such as gauges, valves, and relief devices and their function.
- Always review the vendors safety data sheet (SDS) for the material you will be using.
- Ensure that equipment surfaces are very clean. Greases, waxes, or other impurities could react with certain cryogen liquid/gas or condensed room oxygen to cause a fire.
- Uninsulated components may form some degree of ice buildup due to the cold temperature of the cryogen interacting with moisture in the air. Take care that the ice does not interfere with pressure relief systems.
- If liquid appears on cryogen supply equipment it might indicate the presence of liquid oxygen which can condense out of the room air at certain temperatures. In this case, make sure combustible materials and sources of ignition are not present and ensure good ventilation in the vicinity. Make sure not to seal components that have liquid oxygen on them in a closed system because as they come to room temperature they will expand and present an explosion hazard.
- Do not immerse gloves in cryogens. If you immerse gloves you may get frostbite or burns. They will only provide short-term protection from accidental contact with the liquid.
- Use tongs with insulated handles to withdraw objects immersed in cryogenic liquids.
- Keep flammable or oxidizing liquid cryogens away from organic materials and ignition sources.
- When filling cryogenic liquids into equipment from an open dewar. Do not pour over your head level. Use a step ladder and work from above.
- When using secondary transfer containers, make sure they are specially designed to hold liquid nitrogen.
- Contact the manufacturer or vendor and have the dewar checked in the case of unusual ice buildup on the outside of the dewar, continuous venting through a pressure-relief valve, or any visible damage or malfunctioning of the dewar.
- When using vials, use only those rated for cryogens as these are designed specifically for this purpose. Visually inspect each vial prior to use to ensure that there are no defects.
- Allow vials and other containers that have been in contact with cryogens to warm slowly to minimize sudden pressure differentials.
- Ensure that all dewars and cryogen containers are labeled with “Cryogen” and the name of the product (e.g., Liquid Nitrogen).
- Shield or wrap fiber tape around glass containers receiving cryogenic liquid to minimize flying glass and fragments should an explosion occur.

TRANSPORTATION OF CYLINDERS/DEWARS

- Transportation of dewars should be done by at least two people.
- Do not roll the cylinders by holding the neck, as it is the main support for the inner vessel of the container and is susceptible to damage. Always use proper dollies or carts for moving storage containers.
- If transporting cryogen containers on an elevator, even if they are thought to be mostly empty, no individual should stay on the elevator with the cryogen container while the doors are closed. One person should be located on the floor where the elevator is sent from, and one person should be at the elevator’s final destination. Before sending the elevator, place a sign on the dewar that reads “DO NOT ENTER – CRYOGEN HAZARD”. This sign notifies anyone not to enter the space in the case that the elevator door opens on intermediate floors between origin floor and the destination floor.
- Never transport a cryogen or dry ice in an enclosed vehicle where the storage space is linked to the driver or passenger space. Transporting cryogens and cylinder/dewars under pressure must comply with all DOT shipping requirements.

TRANSFER OR FILLING CYLINDERS/DEWARS

- Dewars, and other storage vessels are available in a variety of shapes and sizes and are rated differently. Always use a dewar or storage vessel rated for the cryogen you are refilling.
- Never leave a filling process unattended.
- Verify the desired operating pressure valve setting before opening any cylinder valves. This is done by looking for markings on pressure gauges on the cylinder. Do not exceed 22 psig for liquid withdrawal unless following a specific procedure that requires higher pressures.
- Transfer, pouring or filling should be done carefully to avoid splash.
- Attach only transfer lines with the correct fitting and a phase separator to avoid splashing when filling into an open container. Place the phase separator so that it rests on the bottom of the dewar. Do not allow the cryogen to splash.
- When dispensing into a small dewar or transfer container, set the container on the floor. Do not hold it while dispensing the cryogen.
- Use stainless steel or other rated material transfer lines. Do not use plastic or Teflon tubing as they will become brittle from the cold temperature.
- Never fill a container higher than the indicated maximum level.

EMERGENCY RESPONSE

Exposure

- If liquid is splashed in the eyes, flush with water for at least 15 minutes. Seek immediate medical attention.
- Skin contact may cause frostbite and burns. Do not rub the area. If clothing is frozen to the skin leave it in place until it separates. Immediately soak affected body part in tepid water and seek medical attention by calling UMPD at 301-405-3333.
- If you experience dizziness, drowsiness, or nausea while working with or near a cryogen, shut off the dewar and remove yourself from the area and get fresh air. Seek medical assistance. When it is safe to do so, notify your PI and ESSR at 301-405-3960. Do not return to the area until ESSR says it's safe to do so.
- If you find someone that has been overcome by a potential cryogen release (e.g., unconscious on the floor) do not approach the victim. Call UMPD at 301-405-3333 and evacuate the area.

Spill/Uncontrolled Release

- Assess the extent of danger. If the spill/uncontrolled release is in a poorly ventilated space then a dangerous condition exists. It is likely that any small spills or releases of a cryogen will convert to gas instantaneously. If a dangerous condition exists, follow guidance below.
- For any large spill/release or if a spill is beyond the capacity of the laboratory to address:
  - Attend to injured persons and remove them from exposure if doing so will not present an exposure to yourself.
  - Alert people in the laboratory to evacuate.
  - Close doors to affected area and evacuate the area.
  - If it is suspected that spill or release migrates outside of laboratory to other occupied spaces, activate building evacuation alarm.
- Call 301-405-3333 from a safe location to report the spill.

REFERENCES AND ADDITIONAL RESOURCES

1. University of Washington, SOP - Handling of Cryogenic Fluids
2. University of Nebraska, SOP – Cryogenic Material
3. Stanford University, SOP – General Use of Cryogenic Liquids
4. OSHA Quick Facts, Laboratory Safety, Cryogens and Dry Ice
5. Harvard University, Laboratory Safety Guideline - Liquid Nitrogen and Argon
6. Harvard University, SOP – Cryogenic Liquids
7. University of Southern California, SOP – Cryogens and Dry Ice
8. University of Pennsylvania, SOP – Cryogens and Dry Ice
9. Northwestern University, Filling and Maintenance of Liquid Nitrogen Tanks