University of Illinois
F. Seitz Materials Research Lab (MRL)

May 2018

Important Dates and Reminders

May:

DRS Lab Safety Audits Finish

June:

2018 Advanced Materials Characterization Workshop

- June 5th and 6th, 2018
- Information and registration, here

DRS Lab Safety Audit Findings Addressed

- All citations MUST be addressed by June 29th

Safety Newsletter

This month's topic is about cryogens; hazards, safe handling, and emergency procedures. For more information you can visit the DRS page on cryogens.

Cryogens

Cryogens are liquefied gases such as nitrogen, argon, or helium that pose significant hazards due to their low temperatures. They are colorless, odorless and extremely cold. Solid carbon dioxide, referred to as dry ice, has handling hazards due extreme cold (-78 ºC). The boiling points or sublimation points for cryogens are listed in the table below:

Cryogen	Temperature ºF	Temperature ºC
Argon	-302	-186
Helium	-425	-269
Nitrogen	-320	-196
Dry Ice	-109	-78

Hazards

- Extreme cold: low temperatures can cause tissues to freeze immediately, which leads to severe burns and frostbite.
- Asphyxiation: The high rate of evaporation of cryogens displaces oxygen in the surrounding air and can reduce oxygen levels to the point where rapid suffocation can occur without warning. One volume of a cryogenic liquid will expand to about 700 equivalents of gas when evaporated. Oxygen deficiency sets in when the oxygen content drops below 19.5%. The decrease in oxygen accompanied by gradual asphyxia is usually NOT noticeable by the victim. One pound of dry ice will produce 250 L of carbon dioxide gas. Within 24 hours, 5-10 pounds of dry ice can sublimate. Concentrations of more than 0.5% (5000 ppm) carbon dioxide in the air can lead to unconsciousness.
- Pressure: Evaporation can lead to an increase of pressure and possible vessel rupture if cryogens are stored in a container that is not vented correctly.
- Oxygen Enrichment: Because the boiling points of liquid nitrogen and helium are lower than that of oxygen, oxygen can condense and liquefy on outer surfaces of non-insulated lines. Open liquid cryogen containers can condense oxygen from the air into the liquid and reach levels as high as 80% O2, potentially increasing the flammability of combustible materials.
- Argon Condensation: Liquid nitrogen can also cause argon to condense and form liquid argon. This is most common in laboratories that use argon gas in equipment that can potentially be introduced to a vacuum cooled with liquid nitrogen (e.g., manifolds).

Safe Handling, Storage, Transport, & Disposal

When handling cryogens, you should always wear Personal Protective Equipment (PPE) to protect your skin.

Useful Contacts

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- **Gloves**: Wear cryogenic gloves that fit loosely so they can be removed quickly should a splash occur. Do NOT touch dry ice or non-insulated vessels containing cryogenic liquid without wearing cryogenic gloves as your skin will stick to the extremely cold material. Do not wear rubber gloves, as they will harden instantly and you may not be able to remove them.
- **Eye/Face Protection**: Splash goggles are a minimum when handling cryogenic liquids. A face shield is required when a splash is possible, e.g., when filling from a pressurized container into an open dewar.
- **Clothing**: Wear a lab coat, closed-toe shoes, and long pants without cuffs to prevent cryogenic liquid from being trapped next to the skin. Leather shoes are preferred, as leather will shed spilled liquid. Textile or canvas shoes absorb the liquid, bringing it closer to the skin. Such shoes will also be impossible to remove when frozen.

Store all containers with cryogens, pressurized or non-pressurized, in well ventilated areas. Dry ice can be placed in Styrofoam boxes or non-sealed, insulated coolers. Store all cryogenic liquids away from combustible material and do not leave containers uncovered for long periods of times. Use a loose fitting stopper or lid.

When **transporting**, Wear cryogenic gloves and eye protection when transporting containers. Never tip, slide, or roll them on their side. Keep containers vertical at all times. Avoid mechanical or thermal shock. Always push containers on wheels. Pulling can cause injury if they tip and fall on you. Use appropriate carts when moving heavy containers with no wheels, and always secure the container during transport.

Do not transport containers holding cryogens inside elevators at the same time as people. Put the container into the elevator and place a sign on it the cylinder facing the door “Do not enter elevator, asphyxiation hazard” Send the elevator to the desired floor and have somebody there to pick it up. It is best to use service elevators with good ventilation (e.g., with screen walls or doors).

For **disposal**, allow excess cryogens to evaporate naturally in a well-ventilated place. NEVER pour cryogenic liquids down the drain, as the pipes are not made to withstand the low temperature.

Emergency Procedures

Respond immediately if there is an accidental condensation of oxygen or argon. Open the system to the atmosphere. Shut off the source of vacuum if it is present. Place a blast shield in front of the apparatus and allow the system to slowly warm to room temperature. It is important that this is an open system to minimize the risk of an explosion upon warming. The sudden boiling of the cryogenic liquid is a significant hazard. Liquid oxygen mixed with organics increases the explosion hazard significantly. Alert researchers in the area and inform DRS.

If skin or the eyes are exposed to cryogens or the cold vapor, use warm water (up to 108 ºF/42 ºC, NOT above 112 ºF/44 ºC) to restore normal body temperature. Do NOT rub the frozen skin. Seek medical attention. Remove or loosen clothing that may restrict blood flow to the frozen area.

In the case of a large spill or rupture of a container, evacuate the area while alerting others. Oxygen deficiency might make the area unsafe to enter. Call 911.