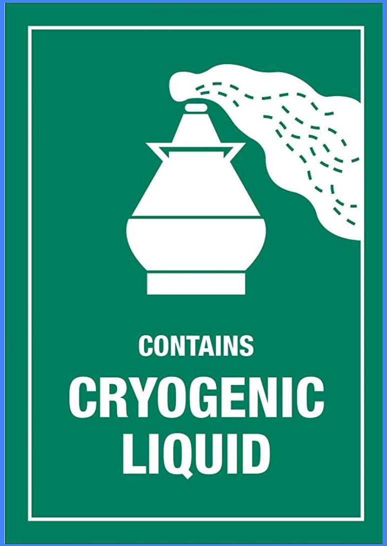
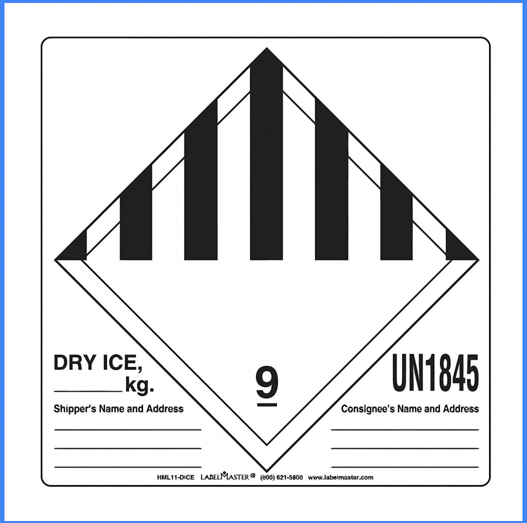
Saint Louis University Liquids, Solids and Gases





Cryogenic Liquids

- Cryogenic liquids are defined as liquids with a boiling point below -130F (-90C).
- Common cryogenic liquids of concern include nitrogen, helium, hydrogen, argon, methane, and carbon monoxide.
- The primary hazards include both physical hazards such as fire, explosion, or pressure, but also health hazards such as chemical toxicity, severe frostbite, or asphyxiation.

Photograph: Getty Images

Cryogenic Liquids - Safety

- Lab coats, safety glasses, and cryogenically rated gloves should be worn.
- Direct contact can cause severe burns. Make sure clothing covers any exposed skin.
- Low temperatures can make valve washers brittle and cause leaks.
- Always use appropriate containers. Ultra-low temperatures may crack plastic or glass containers which are not rated for cryogenic storage.

https://www.asasupplies.com/cryogenic-safety-gloves

Cryogenic Dewars

- Dewar containers are open vessels with a vacuum space between the inner and outer walls used to contain liquid nitrogen.
- Must be kept upright at all times.
- Use proper transport devices (e.g. dolly, cart) and securely restrain dewar.
- Never slide or roll a dewar.

Image: Taylor-Wharton

Cryogenics Health Hazard - Frostbite

- Frostbite symptoms include:
  - Numbness or lack of feeling in affected area.
  - Waxy or discolored skin. Skin may appear flushed, black, white, yellow or blue.
  - Skin and tissue near surface may feel thick.
  - Skin may blister.

LN2 Burn Week 1

LN2 Week 2

https://slideplayer.com/amp/9345423/

Cryogenics Health Hazard - Asphyxiation

- Oxygen deficiency can result from displacement of oxygen by compressed or cryogenic gases.
- When oxygen levels continually decrease below 19.5% by volume, a range of symptoms include:
  - Headache
  - Drowsiness
  - Dizziness
  - Vomiting
  - Excess salivation

https://policy.wisc.edu/attachments/UW-6067/6067_figure_1.JPG

Texas A&M University - Liquid Nitrogen Incident

https://www.tdi.texas.gov/fire/documents/fmred022206.pdf

Figure 2 - Hallway Outside Laboratory Showing Explosion Damage

At approximately 3:00 a.m. on Thursday, January 12, 2006, an explosion occurred in a state university chemistry building laboratory, causing substantial building damage. The explosion resulted from a rupture in a liquid nitrogen (Dewar) cylinder. The cylinder was originally constructed and tested in December 1980.

The State Fire Marshal's Office, in cooperation with the university's environmental health & safety office, conducted an investigation that included an assessment of the building damage and reconstruction of the events leading to the explosion. The resulting examination revealed catastrophic failure of the cylinder. The failure permitted rapid expansion of the nitrogen gas, blowing out the bottom of the tank and propelling the cylinder upwards.

The examination revealed that the cylinder's pressure release valve and rupture disc had been replaced by two brass plugs. Without these two features in place, the cylinder's rupture-prevention function became compromised. During the investigation, lab students related that the bottom portion of the cylinder had been frosting for approximately twelve to eighteen months, suggesting to them that the cylinder was "leaking". It is speculated that the tank was relieving normal excessive pressure through an old leaking gasket on the top of the tank (the actual pressure-relief function had been plugged). Approximately twelve hours prior to the explosion, one of the students replaced the leaking gasket and refilled the cylinder. As the old gasket that helped relieve internal pressure had been replaced, the now full cylinder was completely sealed. The cylinder ruptured when its internal pressure rose above 1,000 psi.

Figure 3 - Inside the Laboratory after Explosion

The catastrophic failure of the nitrogen cylinder was a direct result of the removal and subsequent plugging of the internal tank pressure relief devices. The cylinder was modified by inexperienced and unidentified person(s) resulting in the eventual failure of the cylinder. It could not be determined when the modifications took place.

Gas Cylinders

- Used to store compressed gases.
- Should be stored upright in cool, dry, well ventilated space.
- Must be secured with chain or strap, even if empty.
- Valve cap must be on during storage and whenever moving.
- Should be moved using a cylinder cart. Don’t roll cylinders by hand.
- If a cylinder falls, don’t attempt to catch it.

https://www.justrite.com/news/gas-cylinder-safety-five-tips/

Gas Cylinder Safety Video

Compressed Gas Cylinder Incident

University of Hawaii: Lab Explosion involving a Gas Cylinder

https://www.cwu.edu/resources-reports/sites/cts.cwu.edu.resources-reports/files/documents/UofH%20Lab%20Explosion.pdf

In March 2016, a postdoctoral researcher working at the University of Hawaii's Hawaii Natural Energy Institute (HNEI) was preparing a mixture of hydrogen, oxygen, and carbon dioxide when an electrostatic discharge ignited the gas mixture. The resulting explosion completely amputated the researcher's arm and caused over $800,000 in damages to the research lab.

As a result of an investigation by the Hawaii Occupational Safety and Health Division (HIOSH), the University of Hawaii was fined $69,300 for multiple violations of Hawaii Administrative Rules (HAR). The researcher injured in the March 2016 has since filed a negligence lawsuit against the University of Hawaii and Principal Investigators responsible.

Dry Ice Properties and Handling

Properties

- Dry ice is the solid form of carbon dioxide (CO2).
- Dry ice is extremely cold (−109.3 °F / −78.5 °C) and rapidly sublimates, or converts, into carbon dioxide gas at room temperature.
- Dry ice is available as flakes, pellets, or in blocks.

Handling Dry Ice

- Use protective gloves or tongs.
- NEVER handle with bare hands or place in mouth.
- Do not place or dispose of in sinks.

https://www.thecarycompany.com/82-gallon-insulated-bin-hinged-lid-castors

Dry Ice Storage and Transportation

Storing Dry Ice

- Store in cool, well ventilated areas.
- If possible, ventilation systems should exhaust from lowest level.
- Install carbon dioxide monitors.
- Check carbon dioxide levels before entering storage areas.
- NEVER store in airtight containers.

Transporting Dry Ice

- NEVER transport in airtight containers.
- Open windows or ensure constant supply of fresh air in vehicles.
- Classified as a Dangerous Good under the Department of Transportation (DOT).

Other Lab Incidents - Dry Ice

https://www.ehs.washington.edu/system/files/resources/Recent_UW_SafetyRelated_Incidents.pdf

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Hand Injury at Cabrini Tower

On July 8, 2016, a clinic received a shipment of research media in a sealed container packed with dry ice. Upon opening the package, an employee noticed the container was bulging and placed it behind a Plexiglass shield in an unoccupied room. The employee put on safety glasses and thick gloves and attempted to loosen the lid to slowly release the pressure within the container. The container exploded and injured the employee's hand, resulting in partial amputation.

The container used for shipping the contents in dry ice did not have any ventilation holes, which are needed for dry ice packaging to prevent pressurization from off-gassing. Even though the employee who opened the package was wearing protective equipment, it still was not sufficient to protect them from the hazards of the inappropriate container used to ship the dry ice. If a bulging shipping container is received, no attempt to open the container should be made.

Emergency Response

Oxygen Deficiency

- Move personnel to a well-ventilated area.
- Call DPS at (314) 977-3000.
- Provide appropriate First Aid or CPR until emergency personnel arrive.

Burns/Frostbite

- Remove cold or wet glove/clothing unless frozen to skin.
- Seek medical attention at Concentra Urgent Care or Emergency Department at SSM Health Saint Louis University Hospital for after hours care.
    - *Please take this opportunity to review the January slide deck focused on the OHP!*

Summary

- Please complete the Safety Awareness Quiz on Solids, Liquids, and Gases by June 30th, 2023.
- Please contact ehs@slu.edu for any questions.