University of Nebraska Lincoln

Safe Operating Procedure

(Revised 12/17)

CRYOGENIC MATERIAL

Definition
Cryogenic liquids have boiling points of less than -90º C (-130º F) at 14.7 psia (1 bar). All cryogenic liquids are gases at normal temperatures and pressures. When placed under pressure in specially designed storage containers, the gases condense to a liquid state and maintain very cold temperatures.

Types of Cryogens & Hazards
Various gases can be used as cryogenic liquids. The most common cryogens used at UNL are nitrogen and helium, which are odorless and colorless. Both liquid helium and nitrogen are simple asphyxiants. Therefore, they do not have associated permissible exposure limits (PELs) or threshold limit values (TLVs). The hazards associated with these cryogenic liquids are contact with the skin or eyes, which causes frostbite; and displacement of oxygen from the room, which can create an atmosphere that is insufficient to support life. While inert, rapid release of cryogenic liquids can condense oxygen in the air thereby creating a localized oxygen-enriched atmosphere. This localized oxygen-rich atmosphere may pose a fire risk in the presence of organic matter and an ignition source.

Less common cryogens, such as propane, hydrogen, and oxygen, present risk of fire due to their inherent flammability, while others are toxic. Consult the Safety Data Sheet (SDS) for the particular cryogen being used for a complete discussion of associated hazards.

Cryogen Containers
Cryogens are generally shipped in specially designed cylinders. Cylinders can be designed with an operating pressure of 230 psig (some as high as 350 psig) or as low as 22 psig. Low pressure cylinders are intended for cryogenic liquid withdrawal. High pressure cylinders are typically designed to allow for either gas withdrawal (at a high pressure) or liquid withdrawal (at a low pressure). There are different valves for the high pressure gas withdrawal and the low pressure liquid withdrawal. The liquid withdrawal valve is used to transfer cryogenic liquid to a daily use, non-pressurized dewar.

All containers (cylinders and dewars) will “leak” heat which causes the liquid to slowly change to a gas thereby creating pressure. Cylinders are equipped with pressure relief valves and rupture disks that vent excess pressure. Holding containers such as dewar flasks are equipped with loose fitting lids to allow excess pressure to vent. These pressure venting features are critical to the safe operation of cylinders and containers. As excess pressure is vented, a visible fog and/or frosting on the container will be seen.

Safe Work Practices

- Always verify the desired operating pressure/valve setting before opening any cylinder valves. This is done by looking for markings/pressure gauges on the cylinder. Do not exceed 22 psig for liquid withdrawal!
- Never change an outlet connection that is provided on the cylinder by the supplier.
- Proper Personal Protective Equipment (PPE) must be worn when working with cryogens, including opening valves, dispensing cryogenic liquids, or placing items into or removing items from a cryogen. This consists of eye protection, faceshield, long pants (without cuffs), lab coat that fully covers the arms and torso, closed-toed shoes, and thermal gloves. Remove jewelry or other items that could trap spilled liquids against the skin.
- Use thermal or leather gloves when touching items that have been in contact with cryogens. Use tongs to remove or place items into cryogenic liquids. Splattering will occur anytime an item is placed into or removed from a cryogenic liquid. Items removed from a cryogen will change temperatures/pressures very rapidly, which can result in container failure sending shards of plastic everywhere. Thus, eye and face protection is critical.
- Contact of the skin with cryogens or items that have been supercooled by a cryogen can cause severe burns or frostbite. If eye or skin contact with frostbite occurs, remove restrictive clothing, flush the affected area with tepid (NOT HOT) water and seek medical attention. Do not rub the affected area or use dry heat to warm.
- Cryogenic gases can cause asphyxiation by displacing oxygen in the air because of their very large expansion ratios (700 – 900). As an example, an abrupt release of only 3 liters of liquid nitrogen in a 12x12x8 room would result in an oxygen deficient atmosphere (< 19.5% oxygen)[1]. Indoor use, storage, and dispensing areas should be mechanically ventilated (minimum of six air changes per hour). Passive ventilation is not recommended. An oxygen sensor and alarm (or sensor specific to the gas in use) should be used in areas where the size of the largest container exceeds the available room capacity to the extent that an oxygen deficient atmosphere could occur in the event of a release; and in areas equipped with stationary containers that are filled from a delivery truck and the equipment is not vented to the outdoors. Oxygen sensors/alarms are recommended for gases that are simple asphyxiants and that do not have good warning properties (i.e., odor). Specific gas monitors/alarms are recommended for gases that present other hazards (i.e., toxic, flammable).
- Pressure relief valves on cylinders serve an important safety function- they allow gases to escape to prevent over-pressurization. Do not block, seal, or otherwise tamper with the valves. Caps on dewars are designed to be loose-fitting to allow for gases to escape. Never completely seal a dewar.
- Never use a thermos bottle or other device that has not been specifically designed for cryogenic service.
- When working with cryogenic liquids, ensure that equipment is scrupulously clean. Greases, waxes, or other impurities could react with the liquid/gas or

condensed room oxygen to cause a fire. Use and store cryogens away from ignition sources.

- Store and move cylinders only in an upright position. Do not drop, tip, or roll containers. Use mechanical handling devices for safely moving large containers and secure the container during transport.
- Avoid transporting containers or cylinders in a passenger elevator.
- Recognize that many materials can become brittle and prone to failure in contact with the extremely cold temperatures of cryogens.
- Use only cryogenic storage vials that are designed specifically for this purpose, and visually inspect each vial prior to use to ensure that there are no defects. Do not reuse vials.
- Allow vials and other containers that have been in contact with cryogens to warm slowly to minimize sudden pressure differentials.
- Label cylinders and dewars with “Cryogenic gas/liquid” and the name of the product (i.e., Liquid Nitrogen).

[1] http://www.oxigraf.com/technical_support.html