CRYOGEN USE AND STORAGE GUIDELINES

All cryogenic liquids are gases at normal temperatures and pressures and must be cooled below room temperature before an increase in pressure can liquefy them. Cryogens have boiling points below -150°C (- 238°F), although carbon dioxide and nitrous oxide have slightly higher boiling points and are often included in this category. Different cryogens become liquids under varying conditions of temperature and pressure, but all have several potential hazards in common, which are outlined below.

Potential Hazards

Extreme Cold

Direct contact with the liquid, vapor or non-insulated parts of equipment used to transfer cryogens will immediately freeze body tissue and cause frostbite and effects on the skin similar to a thermal burn. In addition, unprotected skin can adhere to cryogen cooled metal surfaces and tear when pulled away.

Asphyxiation

Cryogens expand exponentially when converted from a liquid to a gas as it warms. It is possible that enough oxygen is displaced during this expansion for asphyxiation to occur.

Structural Embrittlement

The extreme cold temperatures of cryogenic liquids and boil-off gases can cause structural embrittlement. Materials that are normally structurally sound such as carbon steel, zinc, plastic and rubber can become brittle and fail due to thermal stress fracturing when subjected to cryogenic temperatures. Dissimilar metals that have different coefficients of expansion can also suffer stress fractures when exposed to the extreme cold of cryogens and rapid, unanticipated structural failure can pose a severe physical hazard.

High Pressure

During vaporization, the volume increases substantially and changes in pressure will occur. This could cause an explosion if the expansion were to occur in an enclosed space such as an unvented container or plugged venting tube.

Precautions and Controls

Personal Protective Equipment

Personal protective equipment (PPE) must be worn whenever handling cryogens. In addition to the standard laboratory apparel of closed-toe, solid top shoes and long pants without cuffs, insulated cryogenic gloves must also be worn. A face shield is also required when handling cryogens under pressure such as dispensing from a pressurized container into an open dewar. PPE requirements for cryogen handling are identified in the Yale University procedure on the selection and use of PPE and attire in laboratories (Laboratory Safety PPE procedure).

Ventilation

Cryogens must be used and stored in areas with adequate ventilation to prevent creating an oxygen deficient atmosphere. Standard laboratory ventilation is normally adequate to prevent significant displacement of oxygen by cryogenic gases, which are being released under normal circumstances such as a small release when a dewar's pressure relief valve opens to release the internal pressure. However, care must always be taken because there are scenarios in which even a release of gas from a lab-size dewar could cause the oxygen levels of the room to become dangerously low. In addition, throughout campus there is equipment which uses larger amounts of cryogens including MRI, NMR and superconducting detector magnets. A release of cryogen from these units could cause a significant decrease in oxygen levels in the room. During the installation of this equipment, EHS will perform a risk assessment to determine if additional ventilation measures are necessary.

Oxygen Monitors

There are circumstances during which cryogens may be used or stored in areas where the ventilation is inadequate or recirculated. In these situations, either fixed or personal oxygen monitors may be necessary. Rooms housing equipment containing large amounts of cryogen may also require fixed oxygen monitors in addition to specialized ventilation. EHS will determine when such monitoring is necessary and must approve all fixed oxygen monitors prior to installation. In many cases, personal oxygen monitors are worn during the filling of large magnets or other equipment in areas where there are no fixed monitors. In the event any oxygen monitor is activated, all personnel must immediately leave the room and not re-enter until oxygen levels return to normal. Facilities can increase the airflow to the room if notified that the oxygen alarms are activated to help in returning conditions in the room to safe levels.

Safe Handling

In addition to the precautions and controls listed above, the following safety measures should also be taken:

- Avoid contact with uninsulated cryogenic piping, systems and reservoirs.
- Do not store cryogenic liquids in walk-in cold rooms.
- Never store a cryogen in a sealed container at a temperature above the boiling point of the cryogen as the pressure resulting from the production of gas can lead to an explosion.
- Do not tamper with pressure relief devices on equipment designed for cryogen use/storage. Constant/non-stop venting is a sign of a broken valve.
- Periodically inspect equipment and remove ice and frost blockages from openings to prevent over pressurization (LN2 vents will always build frost and ice on filling).
- Never pour a cryogen on tiled or laminated surfaces as this may severely damage the surface.

Personal Exposures and Spills

Exposure

If a cryogen is spilled on skin or there is contact with cryogenic material, immediate medical attention is necessary.

- Remove PPE and clothing that may contain cryogen material quickly upon contact.
- Material that may be frozen to the skin should be left in place and removed only by medical professionals.
- For minor burns, follow up at Yale Health Acute Care/Employee Health or YNHH emergency room.
- For more serious exposures, immediately summon emergency medical assistance by calling 911.

Spill

Large spills of cryogens, or smaller spills in confined spaces or areas without adequate ventilation, can lead to an oxygen deficient atmosphere. In these situations, the area must be immediately evacuated. Call the EHS emergency line at 203-785-3555.