Standard for Inert Cryogenic Liquid Usage in the Laboratory

In University workplaces, the storage, handling and dispensing of cryogenic liquids (e.g. liquid nitrogen, liquid helium, liquid argon) can lead to serious workplace injuries due to hazards related to oxygen deficiency, contact with extremely cold materials, oxygen condensation, or pressure build-up. Appropriate controls must be implemented wherever cryogenics are in use.

This standard outlines some general safety precautions to be taken when working with inert cryogenics, and is based on standard industry practice. Specific procedures are the responsibility of the supervisors or Principal Investigators.

The legislative basis of this standard is the general duty clause of the Occupational Health and Safety Act (OHSA) RSO 1990 section 27(2)c which states that a supervisor must "take every precaution reasonable in the circumstances for the protection a worker".

Scope

This standard covers all areas at the University of Toronto where cryogenic materials are used, and any worker who supervises or performs work with inert cryogenics. This standard does **not** apply to reactive, toxic or flammable gases such as oxygen and hydrogen, as these materials have special additional hazards.

Note: In this standard, "worker" includes faculty, staff, students and visitors.

Definition

- A cryogenic liquid is defined as a liquefied gas that is stored or used at cryogenic temperatures. Cryogenic temperatures are defined by the NIST (National Institute of Standards and Technology) as being below 93.15 K (-180◦C).
- Common examples: nitrogen, argon, neon, helium.

Responsibilities:

Managers, or Supervisors or Principal Investigators shall:

- Ensure that only workers who are informed about hazards, controls, safe work and emergency procedures can conduct work with cryogenics.
- Provide and maintain appropriate equipment and materials to work safely.
- Ensure that all appropriate precautions are being followed and that required personal protective equipment (PPE) is being worn.
- Develop and implement appropriate standard and emergency operating procedures for activities associated with the storage and transfer of cryogenic liquids within and between buildings.

Workers shall:

- Work in accordance with the standard and emergency operating procedures.
- Ensure equipment is in good condition before use, and report any defective or missing equipment.
- Wear appropriate PPE as required.

Training

Managers, Supervisors, and Principal Investigators shall ensure that workers receive training in the following.

- Specific instructions on how to use equipment safely.
- Functioning of “fail safe” devices, and how to ensure they are working properly.
- Safe handling of the cryogen as a liquid and as a gas
- Materials that are and are not compatible with cryogens.
- Use and care of personal protective equipment (PPE).
- Emergency response to fires, leaks and spills, including first aid.
- Good housekeeping practices.

Good Handling Practices

- Cryogens must be handled in a well ventilated area. As much as possible this means work should be conducted in a fume hood.
- Cryogens may only be used in a fume hood where there is no forced air ventilation. This is usually only the case for labs in older buildings.
- Where transfer of cryogens is occurring, the equipment should never be left unattended.
- Cryogenic liquids and their containers should be kept free of contaminants of any kind.
- Absorbent materials should not be exposed to cryogens.
- When a cryogen is vented, it should be to the outdoors, for instance via a fume hood.
- Label containers with a WHMIS workplace label.
- Do not overfill containers.
- When filling containers or inserting objects into a cryogen, minimize boiling and splashing by proceeding slowly.

Transport of Cryogenic Materials Within Buildings

- Containers should be transferred in handcarts or other devices designed for moving cryogenic liquid vessels.
- Cryogenic materials should not be carried up the stairs due to the risk of tripping and spilling.

- They also should not be carried by someone up the elevator. If the elevator were to suffer a breakdown, the cryogen could displace the oxygen in the elevator leading to consequences potentially including death. The exception would be for quantities less that 1L of cryogen, as that quantity would not be enough to cause asphyxiation in even a small elevator.

Procedure for Transfer of Cryogens Between Floors

Send cryogenic liquids in elevators without any passengers and ensure that no passengers get on the elevator while the cryogen is being transported. The elevator should have a chain across the entrance on the inside of the doors with a sign saying “warning, cryogenic materials in transport - do not enter”. The elevator may also be put “in service”, with someone to meet the elevator at the destination end, in which case the sign is not needed.

Vessels for Use With Cryogens

- All vessels used for cryogens must have a pressure release system to ensure that pressure cannot build up resulting in an explosion. For example Dewar flasks should have a cover that allows for boiled off gases to escape. Vessels should meet ISO 21009-1 or equivalent.
- Any vessel used for containing cryogenic materials must be specifically designed for use with cryogenics. For example a “thermos” flask for food storage would not be appropriate.
- Cryogenic materials that have a boiling point below that of oxygen such as nitrogen, helium, argon and neon can cause oxygen to be condensed out of the air as pure liquid oxygen. Pure liquid oxygen is a potent oxidizer that has been known to cause relatively inert materials such as grease and wood to explode. The areas where liquid oxygen tends to accumulate is on poorly insulated or exposed vessels, piping or in the cryogen itself.

Personal Protective Equipment (PPE)

Frostbite occurs almost instantly when skin is wet, for instance from sweat. With dry skin it has been shown that a thin layer of gas forms next to the skin on liquid cryogen exposure, insulating the skin from the cryogen for a very short

exposure and very small quantities. However with longer exposure like with a flow of cryogen, on where the cryogen is sitting on the skin, frostbite is common.

Cryogen splashed into the eye can cause immediate frostbite and severe eye damage. To protect against these hazards the following PPE should be used.

- Loose fitting cryogen rated gloves should be used when handling materials that have come in contact with cryogens. They are also appropriate for other cryogen handling tasks.
- Leather gloves designed for handling cryogens may be worn when handling non- chilled materials as they allow cryogenic liquids to flow off the glove without contacting the skin. This provides protection for small splashes that result in exposures of short duration. However leather gloves provide no insulation and cannot be used to handle materials at or near cryogenic temperatures.
- Tongs can also be used for many tasks however gloves should still be worn to provide splash protection.
- When pouring cryogens or using an open vessel that may boil and splash, goggles plus a full face shield must be worn as per Canadian Standards Association (CSA) Standard Z94.3-02 and the U of T Protective Eye and Facewear Standard. The face shield protects the face and neck, while the goggles ensure that no splashes can enter the eyes.
- Closed toe shoes, a non-porous lab coat, and long pants must be worn. Cuffs of any type should be avoided, as they can trap cryogens close to the body.
- The bottoms of the pants should cover past the tops of the shoes to ensure that no cryogen can be inadvertently poured into the shoe.
- When large quantities of a cryogen are in use a non-porous apron such as leather should be worn.
- No watches, rings or other jewelry should be worn, as a splash can freeze these objects to the skin.

In the Event of a Spill

- Cryogens penetrate clothing much more quickly than water, so remove any contaminated clothing immediately.
- For large spills, leave the area immediately, and call both 911 and 416-978-7000.

Further Information

- CCOHS – Canadian Centre for Occupational Health and Safety
  - http://www.ccohs.ca/oshanswers/chemicals/cryogenic/
- Compressed Gas Association
  - http://www.cganet.com
- NFPA 55 – Standard for the Storage, Use, and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders, and Tanks