Cryogenic Gases & Solid Carbon Dioxide

Cryogenic gases in the form of liquid nitrogen and helium are often associated with work in laboratories within the University
The properties of these gases are as follows

Property	**Nitrogen**	**Helium**
Boiling point [1]	-196^{0}C	-269^{0}C
Liquid /gas ratio [2]	683	739
Volume of liquid per m^3 that will reduce the oxygen level to 19%	0.14 litre	0.13 litre

[1] Temperature at which gas turns to liquid
[2] this is the expansion factor. 1 litre of liquid nitrogen will expand to produce 683 litres of gas.

Hazards associated with the use of these gases are:

- **Asphyxiation due to oxygen deficiency,**
  Normal atmosphere contains 20.9% oxygen by volume. Increasing the amount of cryogenic gas into the environment will displace the oxygen. The physical effects are increasing pulse rate tiredness, headaches and dizziness, fainting. The severity and speed of onset of these effects increase as the oxygen level decreases and beneath 10-12% they can occur without the person's knowledge, without prior warning and can prove fatal. The liquid gas ratio indicates the volume that 1 litre of liquid gas will expand to fill when spilt. This happens instantaneously and thus a spill of liquid gas in a poorly ventilated room can have very serious consequences.

  Precautions. Confined spaces present a problem. Store and dispense gas only in well ventilated areas. A risk assessment should have been carried out to establish if the oxygen concentration could drop below 19% in the event of spillage. If this is the case consideration must be given to provision of an oxygen monitoring system for the work area.

  Lifts are confined spaces and cryogenic gases must not be transported in them unless a risk assessment has established that oxygen deficiency will not occur under the conditions and quantities to be used. If oxygen deficiency could occur then the vessel should be unaccompanied. The use of additional personnel and barriers will be required to prevent entry into the lift. These measures should be described in a standard operating procedure. Further advice can be obtained from the Safety Office, which can carry our oxygen monitoring.

- **Cold burns.**
  Prolonged exposure may lead to frostbite and the destruction of body tissue. This may not be immediate or obvious. Also the skin may freeze instantly to cold surfaces and attempts to remove the skin can cause serious damage.

  Precautions. The following personal protective equipment should be worn.

  - Lab coat with apron over top will prevent liquid gas entering pockets and areas where spillage can collect.
  - Thermal gloves of non-absorbent waterproof material. They should be securely banded at the wrist or arm.
  - Full-face visors must be worn to prevent liquid splashes to eyes, face and mouth.
  - Full shoes that extend up the ankle allowing trousers to fit over the shoe.
  - Tongs and forceps for handling vials.
  - First aid response is given in Section 4.4 of this manual.

- **Cold effect on lungs.** Inhalation of cold mists, gases or vapours can be serious and lung damage may result. This will be a consideration for larger scale use.
  Precautions: Ensure area is well ventilated and wear a face visor.

- **Ice plug formation.** These may form in the neck of Dewars when moisture comes into contact with the cold gas in the neck of the Dewars. This can then form a seal across the neck preventing normal venting and leading to increased gas pressure. The ice plug may be ejected at high velocity or the Dewar may explode.

  Precautions
  - Always fit the Dewar's protective cap
  - Ensure the cap is in good condition
  - Do not leave uncapped Dewars outdoors in moist environments
  - Ensure Dewars are fully emptied after use
  - In the event of an ice plug being found in the neck of the Dewar immediately evacuate the area.
- **Rapid expansion**

  Dewars that have a seal around the top, between the inner and outer skin are prone to problems if this seal is not in tact. [See right] Liquid gas can get trapped between the inner borosilicate glass chamber and outer metal and due to the high expansion value this can cause the inner chamber to implode.

Precautions In order to avoid this hazard it is recommended that and alternative type of dewar is used that does not have a seal around the top are used. If this type of Dewar remains in use managers must ensure that users are made aware of this potential problem and of the importance of inspecting the seal carefully before each use to ensure it is intact.

- **Oxygen enrichment.** This may occur around the hose of a pressurised Dewar, or in the bottom of an open Dewar. Since liquid nitrogen and liquid helium are colder than the boiling point of liquid oxygen, air coming into contact with a very cold surface will cause oxygen to condense out of the air. Liquid oxygen may drip from the hose giving the impression of a leak. These effects can result in oxygen-enriched air being formed, which present an additional fire hazard. Also cryogenic liquid oxygen dripping onto surfaces might cause embrittlement.

  Precautions. No smoking or naked flames in the vicinity of cryogenic transfer.

Solid Carbon Dioxide Ice [Cardice]
Cardice will produce carbon dioxide gas, which is an asphyxiant. It is also is extremely cold and can cause cold contact burns. The precautions outlined for the hazards associated with cryogenic gases should be adopted for handling cardice.

First Aid Treatment for cryogenic/cold burns

Apply copious amounts of tepid water to the affected area of skin to reduce freezing in the tissue, loosen any clothing that may restrict blood circulation and move the injured person to a warm place but not a hot environment. Do not apply heat to any affected parts. To protect frozen areas apply a loose, non-fluffy sterile dressing. Seek medical attention immediately.