LA TROBE UNIVERSITY

GUIDELINES FOR THE MANAGEMENT OF CRYOGENIC LIQUIDS

INTRODUCTION

The purpose of these guidelines is to provide information to staff & students at La Trobe University relating to the transport, storage, use, handling and disposal of cryogenic liquids.
Information in this Guideline is based on the Australian Standard: *AS 1894 – 1997 The storage and handling of non-flammable cryogenic and refrigerated liquids.*

CRYOGENIC LIQUIDS

Cryogenic liquids are liquefied gases kept in their liquid state at very low temperatures. All of them are extremely cold with boiling points below - 150° C (- 238 ° F). *("Cryogenic" means "producing or related to, low temperatures")* Carbon dioxide and nitrous oxide are not true cryogenic liquids but are covered by this guideline.

All cryogenic liquids are gases at normal temperature and pressure. These gases must be cooled below room temperature before an increase in pressure can liquefy them. Different cryogens become liquids under different conditions of temperature and pressure, but all have two properties in common: (1) they are extremely cold and (2) small amounts of liquid can expand into very large volumes of gas. The vapors and gases released from cryogenic liquids also remain very cold. They often condense the moisture in air, creating a highly visible fog.

HAZARDS ASSOCIATED WITH HANDLING CRYOGENIC LIQUIDS

Cold contact burns	Cryogenic liquids and low-temperature vapor or gas caused by the evaporation of cryogenic liquids produce effects on skin and flesh similar to a severe burn. Bare skin on contact with uninsulated containers/pipes will be torn on removal
Frostbite	Exposure of skin and flesh to cold atmosphere will result in severe frostbite
Suffocation (Asphyxia)	Atmospheric oxygen is displaced by evaporating cryogenic liquid reducing the available oxygen thus potentially causing asphyxia. This is a significant risk in confined spaces or poorly ventilated areas
Over-pressurization	Cryogenic liquids can evaporate into very large volumes of gas. They have high expansion rates, which average approximately 700 to 1. This means if the volume cannot be expanded the pressure will increase approximately 700-fold or until it blows something out
Lung disorders	Transient and short exposures to cold vapours and gas will produce breathing discomfort. The low temperature of these products means prolonged inhalation even at safe breathing concentrations can affect the lungs and lead to serious illness. Effects caused by inhalation of cold vapours might not be immediately apparent
General body cooling (hypothermia	Low temperatures can affect reactions and coordination. The effects can vary among individuals and might not be discerned by the affected person. An observer might notice the slowing of reactions and lack of coordination

Most cryogenic liquids can be placed in one of three groups:

Inert gases	Do not react chemically to any great extent & do not burn or support combustion e.g. nitrogen, helium, neon, argon and krypton.
Flammable gases	Produce a gas that **can** burn in air. e.g. hydrogen, methane, liquefied natural gas
Oxygen	Many materials considered non-combustible can burn in the presence of liquid oxygen. Organic materials can react explosively with liquid oxygen. Hazards and handling precautions of liquid oxygen must be considered separately

The Occupational Health and Safety Section has published a template risk assessment to assist schools and departments to assess and control risks associated with cryogenic liquids. The form is available on the OHS website at: http://www.latrobe.edu.au/hr/ohs.htm

GENERAL PRECAUTIONS (All areas where cryogenic liquids are stored or used)

- Ventilation should be provided such that any gas or vapor evaporating from any cryogenic liquid (including spills or other releases) is dispersed in such a manner that the oxygen content of the surrounding air **DOES NOT FALL BELOW 18%**.
- The ventilation should be provided by one of the following means:
    - An external wall which incorporates a wire mesh, lattice or louvered opening which does not incorporate any means of closing. Also, the discharge must not be to areas of public congregation or into any basements, pits or trenches.
    - Natural cross ventilation by means of permanent openings
    - Providing continuous forced exhaust ventilation.
- If cryogenic liquids are to be used in areas where there is no ventilation then an alarm (both audible and visual) will be installed and maintained.
- Written procedures will be prepared and all users trained in the correct use and handling of cryogenic liquids. These procedures will be reviewed every time something changes and in any case **every three years**.
- ALL vessels used to transport and store cryogenic liquids will be clearly marked to show the liquid for which the vessel is designed and used.
- The supplier of cryogenic liquids should carry out periodic inspections of the areas where the liquids are delivered, stored and used.
- Sufficient lighting will be provided in all areas where cryogenic liquids are delivered, stored and handled.
- Current, compliant copies of Material Safety Data Sheets (MSDS) will be readily available in all areas where cryogenic liquids are used.
- Current Risk assessments will also be readily available for each activity involving cryogenic liquids.
- Risk assessments should be reviewed regularly and updated when changes occur in the processes involving cryogenic liquids.
- Training will be provided by competent people on issues relating to cryogenic liquids.
- Appropriate Personal Protective Equipment (PPE) includes:
    - Clean, dry clothing which completely covers skin and loose fitting for easy removal
    - Clean, dry, impervious cryogenic liquid gloves.
    - Goggles or a face shield
    - Enclosed footwear

- A suitable first aid station with written first aid procedures should be prepared and readily available.
- An emergency plan must be prepared in consultation with the emergency services, suppliers and regulatory authorities.
- All equipment used for cryogenic liquids will be used as supplied. Modifications to the equipment are forbidden.

DELIVERY AREA / POINT

- The area where cryogenic liquids are delivered will be well ventilated.
- The area will be easily accessible for users.
- Appropriate personal protective equipment (PPE) – *(cryogenic gloves, goggles, clothing which leaves no skin uncovered)* must be used when cryogenic liquids are delivered.
- Other personnel will be notified (by signs or other means that a cryogenic liquids delivery is in process).

TRANSPORT

- Only vessels which have been specifically designed for cryogenic liquids shall be used to transport cryogenic liquids.
- The vessels will be clearly labeled (See General) including appropriate Dangerous Goods diamond.
- The path or route to be taken to transport the containers from the delivery area to the area where used shall be clearly defined and free of interferences *(even surfaces, etc).*
- If a lift is used to transport cryogenic liquids personnel WILL NOT travel in the lift with the cryogenic liquids.
- A clear and legible sign should be placed on the container advising personnel not to enter the lift if the dewar or other container is in the lift.
- Manual handling issues need to be addressed such that containers larger than 10 litre capacity will either have wheels on them or will be placed on a trolley.
- Appropriate Personal Protective Equipment (PPE) must be used when transporting cryogenic liquids.

STORAGE

- Only vessels/containers specifically designed for using with cryogenic liquids shall be used to store cryogenic liquids.
- All containers will be clearly marked and labeled.
- The area in which cryogenics are stored will be well ventilated (see above – GENERAL).
- Cleanliness above normal standards is essential for areas where cryogenic liquids are stored or used.
- When equipment is being cleaned, only suitable solvents and procedures as recommended by the supplier of the cryogenic liquids.
- Entry to areas where cryogenic liquids are stored or used will be controlled.
- The area in and around storage vessels should be maintained in a safe condition.
- Clear access is required (both entry and exit) from areas, rooms or buildings where cryogenic liquids

SPECIAL PRECAUTIONS FOR HELIUM

- Is an inert gas but requires special precautions when in liquid form as vaporization occurs at very low temperatures. Very large quantities can be boiled off extremely rapidly by the insertion of warmer objects or by condensation of air.
- Must be stored at positive pressure to prevent the entry of air into the system because if air is allowed to enter the system it can freeze and block vents, resulting in pressure build up.
- Purging and precooling of equipment for use with helium complicated by the fact that any other gas will freeze on introduction of helium. Where precooling is necessary, nitrogen should be used to purge and precool equipment. Nitrogen should then be removed by purging with helium gas prior to introduction of liquid helium.

HANDLING

- Appropriate containers must be used when handling cryogenic liquids. *(If liquid nitrogen is exposed to the atmosphere, atmospheric oxygen will condense into the liquid. If this is allowed to continue for any length of time, the oxygen content of the liquid can become appreciable and the same precautions as those for liquid oxygen will be required. Due to the possibility of oxygen enrichment, inert cryogenic liquids should not be stored in an open system e.g. in a flask. Indication of oxygen enrichment is a blue tinge in the liquid.)*
- Many materials (such as plastics and some carbon steels can become brittle when exposed to very low temperatures of cryogenic liquids.
    - All materials used with cryogenic liquids will
        - Be compatible with those liquids
        - Be suitable for their intended use
        - Not undergo embrittlement.
- Manual handling should be considered when decanting cryogenic liquids.
- Written procedures should be prepared and made available to all users
- All interior surfaces of containers in which cryogenic liquids will be placed should be free of visible moisture to prevent the moisture from freezing and blocking lines.

DISPOSAL

- Cryogenic liquids must NOT be disposed of by draining into trenches, pits, drains or confined spaces. They should be allowed to evaporate in well ventilated areas in a controlled manner.