SAFE HANDLING OF CRYOGENIC SUBSTANCES

A superconducting magnet uses two types of cryogens (liquid helium and liquid nitrogen). Cryogenic liquids can be handled easily and safely, provided certain precautions are obeyed.

The recommendations in this section are by no means exhaustive, and when in doubt, the user is advised to consult the supplier.

- *Types of substances:* The substances referred to in these recommendations are nitrogen, helium and air. Contact your cryogen supplier or EH&S for the appropriate MSDS sheets for these cryogens.
  - Helium: This is a naturally occurring, inert gas that becomes a liquid at approximately 4K. It is colorless, odorless, non-flammable and non-toxic. In order to remain in a superconducting state, the magnet is immersed in a bath of liquid helium.
  - Nitrogen: This is a naturally occurring gas that becomes liquid at approximately 77K. It is colorless, odorless, non-flammable and non-toxic. It is used to cool the shields which surround the liquid helium reservoir.
- *Cryogen transport Dewars:* During normal operation, liquid cryogens evaporate and will require replenishment on a regular basis. The cryogens will be delivered to site in transport Dewars. It is essential that these cryogen transport Dewars are non-magnetic.
- *Physical properties:* Safe handling of cryogenic liquids requires some knowledge of the physical properties of these liquids, common sense and sufficient understanding to predict the reactions of such liquids under certain physical conditions. The very large increase in volume accompanying the vaporization of the liquid into gas and the subsequent process of warming up is approximately 740:1 for helium and 680:1 for nitrogen.

General Safety Rules

General safety rules for handling cryogenic substances include, but are not limited to:

- Cryogenic liquids remain at a constant temperature by their respective boiling points and will gradually evaporate, even when kept in insulated storage vessels (Dewars).
- Cryogenic liquids must be handled and stored in well-ventilated areas.
- Passengers should never accompany cryogens in an elevator. There is a risk of asphyxiation.

Cryogen Transport Dewars

The rules concerning the cryogen Dewars used to transport cryogenic liquids include, but are not limited to:

- All cryogen Dewars transporting cryogenic liquids must not be closed completely as this would result in a large buildup of pressure. This will present an explosion hazard and may lead to large product losses!
- All cryogen transport Dewars must be constructed of non-magnetic materials.

Health Hazards

Main rules relating to health hazards include, but are not limited to:

- Evacuate the area immediately in the event of a large spillage.
- Provide adequate ventilation in the room to avoid oxygen depletion. Helium can displace air in the upper area of a room and cold nitrogen can displace air in the lower area.
- Do not come in direct contact with cryogenic substances in liquid or vapor form (or as low temperature gases), since they will produce “cold burns” on the skin similar to burns.
- Do not allow insufficiently protected parts of the body to come in contact with non-insulated venting pipes or vessels, since the body parts will immediately stick to them. This will cause the flesh be torn if the affected body part is removed.

First Aid

First aid rules include, but are not limited to:

- If any of the cryogenic liquids come into contact with eyes or skin, immediately flood the affected area with large quantities of cold or tepid water and then apply cold compresses.
- Never use hot water or dry heat.
- Medical advice should be sought immediately!

Protective Clothing

Protective clothing rules include, but are not limited to:

- Protective clothing must be worn mainly to avoid cold burns. Therefore dry leather or cryogenic gloves must be worn when handling or working with cryogenic liquids.
- Gloves must be loose fitting so that they can be removed easily in case of liquid spillage.
- Goggles must be worn to protect the eyes.
- Any metallic objects (e.g. jewelry) should not be worn on those parts of the body, which may come into contact with the liquid.

Others

Other rules of handling cryogens include, but are not limited to:

- Handle the liquids carefully at all times. Boiling and splashing will always occur when filling a warm container.
- Beware of liquid splashing and rapid flash off of cryogens when immersing equipment at ambient temperature into the liquid cryogens. This operation must be carried out very slowly.
- When inserting open ended pipes into the liquid, never allow open ended pipes to point directly towards any person.
- Use only metal or Teflon® tubing connected by flexible metal or Teflon® hose for transferring liquid nitrogen. Use only gum rubber or Teflon® tubing.
- Do not use Tygon® Tubing or plastic tubing. They may split or shatter when cooled by the liquid flowing through it and could cause injury to personnel.

Smoking

Please obey the following basic rules concerning smoking:

- Do not smoke in any rooms in which cryogenic liquids are being handled.
- Designate all rooms in which cryogenic liquids are being handled as “No Smoking” areas, using appropriate signs.
- While nitrogen and helium do not support combustion, their extremely cold Dewar causes oxygen from the air to condense on the Dewar surfaces, which may increase the oxygen concentration locally.
- There is a particular fire danger if the cold surfaces are covered with oil or grease, which are combustible. Self-ignition could occur!

Properties of Cryogenic Substances

Properties	Nitrogen	Helium
Molecular weight	28	4
Normal boiling point (°C) (°K)	-196 77	-269 4.2
Approximate expansion ratio: volume of gas a 15°C and atmospheric pressure produced by unit volume of liquid at normal boiling point.	680:1	740:1
Density of liquid at normal boiling point (kg m^{-3})	810	125
Color (liquid)	None	None
Color (gas)	None	None
Odor (gas)	None	None
Toxicity	Very low	Very low
Explosion hazard with combustible material	No	No
Pressure rupture if liquid or cold gas is trapped	Yes	Yes
Fire hazard: combustible	No	No
Fire hazard: promotes ignition directly	No	No
Fire hazard: liquefies oxygen and promotes ignition.	No	No

Contact EH&S's Radiation Safety team at radsaf@uw.edu or at 206.543.0463

for assistance with shielding, PPE, hazard evaluation and training.