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PREFACE

The purpose of this policy is to provide guidelines and procedures concerning the safe handling, transport, storage, and use of cryogenic liquids.

DEFINITIONS

Cryogenic liquid: liquid with a normal boiling point below -130°F (-90°C). Common industrial gases transported, handled and stored in the liquid state at cryogenic temperatures are Argon, Helium, Hydrogen, Nitrogen, and Oxygen.

Dewars: Liquid Dewar flasks are non-pressurized, vacuum-jacketed vessels, similar to a Thermos bottle. Dewars are designed with either loose-fitting caps or pressure relief valves, that prevents air and moisture from entering, yet allows excess pressure to vent.

Freezer Farm: refers to a collection of multiple freezers, housed in one location.

HAZARDS/SPECIAL PROPERTIES

A. Frostbite/Tissue Damage - Cryogenics are extremely cold and can cause instant, severe frostbite and tissue damage. Cryogen vapors can freeze the skin or eyes faster than liquid contact, and even faster than metal contact. Direct contact with cryogenic liquids, un-insulated cryogenic pipes, or equipment can cause freeze burns and tissue damage. The fluid in eyes will freeze in contact with a cryogen, causing permanent eye damage.

B. Asphyxiation - On vaporization, cryogenic liquids will expand at least two orders of magnitude. Liquid nitrogen, the most commonly used cryogenic liquid, will expand about 700 times. Liquid oxygen will expand almost 900 times. If a cryogenic liquid is vaporized so as to reduce the oxygen percentage below 19.5%, there is a risk of oxygen deficiency and asphyxiation. In confined spaces or poorly ventilated areas (such as cold rooms, elevators, or storage rooms), the expanding gas can displace oxygen, presenting an asphyxiation hazard to staff working in the area. Simple asphyxiants such as nitrogen do not have good warning properties. To prevent asphyxiation hazards, cryogenic liquids must be stored and used in well-ventilated areas.

C. Pressure Buildup and Explosions – Because of their high liquid to gas expansion ratio, cryogenic liquids present a potential explosion hazard when they evaporate. Cryogenics will boil as they sit in their storage vessels by absorbing heat energy from the warmer surroundings. The vessels used to store cryogenic liquids must have a pressure relief valve or venting lid to allow for the release of evaporated gas from the container.

D. Oxygen Enrichment - When transferring liquid nitrogen through un-insulated metal pipes, the air surrounding a cryogen containment system can condense. Nitrogen, which has a lower boiling point than oxygen, will evaporate first. This can leave an oxygen-enriched condensate on the surface that can increase the flammability (combustibility) of materials near the system, creating potentially explosive conditions. In order to minimize the fire hazard potential, equipment containing cryogenic fluids must be kept clear of combustible materials.

E. Material Brittleness – Cryogenic liquids cause many common materials such as carbon steel, plastic and rubber to become brittle or possibly fracture under stress.

GENERAL SAFE HANDLING PROCEDURES

A. Remove metal jewelry/watches on your hands and wrists before working with cryogenics. If exposed to cryogenic liquids or boil-off gases, jewelry can freeze to the skin.

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B. Mandatory Protective Devices

Wear protective clothing	<ol style="list-style-type: none"> Cover all exposed skin by wearing long sleeve shirts, long pants (cuff-less), a long-sleeved lab coat Well-fitted leather (or other impermeable material) shoes (no sneakers, sandals, or open-toed shoes) Wear a protective apron when a splash potential exists or when large quantities of cryogenics are handled.
Gloves	<ol style="list-style-type: none"> Multi-layered insulated gloves designed to provide protection to the hands and arms from the hazards encountered when working with ultra cold materials. Lightweight Flexible Should be loose-fitting to allow for quick removal if cryogenic fluids are spilled on them
Face Shield	<ol style="list-style-type: none"> Protect your eyes by wearing safety goggles Full face shields shall be used in the following situations: <ol style="list-style-type: none"> when a cryogen is poured for open transfers if fluid in an open container may bubble

C. Handling

Transfer or pouring cryogenics	<ol style="list-style-type: none"> Do not allow unprotected areas of skin to touch objects cooled by cryogenic liquids. Use tongs to withdraw objects immersed in the liquid and handle the object carefully Handle slowly to minimize boiling, splashing and spilling Use proper transfer equipment <ol style="list-style-type: none"> A phase separator or Special filling funnel (the top of the funnel should be partly covered to reduce splashing).
If the liquid cannot be poured	<ol style="list-style-type: none"> Use a cryogenic liquid withdrawal device for the transfer (be sure to follow all instructions provided with the device).

D. Storage

Storing	<ol style="list-style-type: none"> Store only in well-ventilated areas.
Containers	<ol style="list-style-type: none"> Do not overfill Do not use hollow rods or tubes as dipsticks, since liquid could be released from the top of the tube. Use wooden or solid metal dipsticks
Using cryogenics	<ol style="list-style-type: none"> DO NOT USE in closed areas, gases can reduce the oxygen concentration and can result in asphyxiation. <ol style="list-style-type: none"> To avoid asphyxiation, an oxygen monitor is recommended when working with a cryogen in a confined space. Do not use in any area where oxygen or hydrogen is stored, handled or used Because some organic materials (oil, grease, asphalt, kerosene, cloth, tar, dirt) can react violently with liquid oxygen, do not lubricate oxygen equipment with oil, grease or unapproved lubricants.

MSDS for Cryogenic Material- See ChemWatch <http://www.hopkinsmedicine.org/hse/msds/index.html>

DEWARS

A. Use containers specifically designed for low-temperature liquids, such as a Dewar. Liquid Dewar flasks are non-pressurized, vacuum-jacketed vessels, similar to a Thermos bottle. Dewars are designed with either loose-fitting caps or pressure relief valves, that prevents air and moisture from entering, yet allows

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excess pressure to vent. Do not connect the tank and the Dewar tightly to avoid pressure build up in the Dewar. Do not use any stopper or other device that would interfere with venting of gas.
B. Cryogenic containers are designed and made of materials that can withstand rapid changes and extreme temperature differences encountered in working with cryogenics. Fill containers slowly to minimize internal stresses that occur when any material is cooled.
C. When hand-carrying cryogen-containing Dewars, ensure the Dewar is your only load (don't carry anything else). Watch for people who may run into you, and ensure that the Dewar is carried with both hands and as far away from your face as comfortably possible.
D. Ensure Dewars are properly labeled with the identity of the cryogen. Do not mix different cryogens in the same Dewar
E. Use care when filling portable Dewars and do not overfill them.
F. Do not cover or plug the entrance opening of any Dewar. Do not use any stopper or other device that would interfere with venting of gas.
G. Keep containers upright at all times except when pouring liquids from Dewars specifically designed for that purpose. Handle containers gently; rough handling can cause serious damage to Dewars and refrigerators. Dropping the container can cause partial or complete loss of vacuum. Do not walk, roll or drag these containers across a floor; uses a dolly or handcart.
H. Keep containers clean and dry. Moisture, chemicals, strong cleaning agents may promote corrosion which should be removed promptly. Use water or mild detergent for cleaning and dry the surface thoroughly. Do not use strong alkaline or acid cleaners that could damage the finish and corrode the metal shell. Follow manufacturer's recommendations.

FREEZER FARMS

A "freezer farm" refers a collection of freezers that are housed in one location. Some of the freezers may use liquid nitrogen, either as a primary or back-up coolant. Because of the large amount of nitrogen being used, it is important that there be adequate ventilation in the area. An oxygen level alarm may also be required. Contact HSE for assistance in determining ventilation and safety requirements. Storage of 10 or more liquid nitrogen cooled freezers must be approved by HSE.

REFERENCES

Compressed Gas Association, CGA P-12, *Safe Handling of Cryogenic Liquids*.

RESPONSIBILITIES

Departmental Management	Enforce this policy. Educate personnel using cryogenic liquids
Health, Safety and Environment	Monitor the proper use, storage and transport of cryogenic liquids during environmental surveys.
All Staff	Store, transport and handle all cryogenic liquids in accord with this policy.

REVIEW CYCLE

Every year.

