

**EEM-EHS**

**EHS**

**Environmental Health and Safety**

**Cryogenic Liquid Use For Piped System at ETIC**

**Standard Operating Procedure**

**1.0 Hazards Associated with Cryogenic Liquids:**

Cryogenic liquids have properties that make them more dangerous to use than other liquids: extremely cold temperatures, high liquid-to-vapor expansion ratios, and flammability for certain liquids.

Skin or eye contact with cryogenic liquids, cold equipment and materials that are used in conjunction with cryogens, or splashing liquid can cause severe tissue damage such as burns, frostbite, tearing of the flesh, and eye damage. Vapors from boiling liquids can also cause eye damage, frostbite to the skin, and oxygen deficient environments. Evaporation of cryogens can cause asphyxiation, fire, and explosion.

NOTE: Please see the attached instructions for filling liquid nitrogen into a dewar from the piped system.

**2.0 Controls:**

**2.1 Engineering Controls:**

* To prevent the build-up of flammable gases and/or the displacement of breathable air, local exhaust ventilation may be required.
* To prevent internal pressure build-up in cylinders of cryogenic liquids, safety relief valves and rupture discs are required.
* To prevent splashing, a liquid/phase separator may be required.

**2.2 Administrative Controls:**

* Do not work alone. Implement the buddy system.
* Attend baseline laboratory safety training (required annually) at the following link - <https://www.uml.edu/EEM/EHS/ehs-training/>.
* Attend laboratory-specific training on filling the dewar from the ETIC piped system.
	+ Document this training in section 8 of the Chemical Hygiene Plan Notebook.
* Review this SOP and the safety data sheet for handling liquid nitrogen as part of your laboratory-specific training on handling cryogenic liquids.
* Utilize tongs and/or forceps to handle frozen materials when applicable.
* Use only approved materials with cryogens. Unapproved materials (such as plastic, rubber, wrought iron, hollow tubes, and carbon steel) will become brittle and shatter. In the case of hollow tubes, the tubes can become over pressurized.
* Avoid moisture coming in contact with storage containers and equipment as it can freeze and plug up the relief devices.
* Avoid heat since it can create an explosion.
* Avoid incompatible materials such as metals and oxidizing agents.
* Periodically inspect equipment and remove ice and frost blockages from openings to prevent over pressurization.
* Ensure cylinders are equipped with safety relief valves and rupture discs to protect from internal pressure build-up.
* Do not tamper with pressure relief valves. Report any leaks or improperly set relief valves to the manufacturer.
* Keep equipment clean without the use of corrosive cleaning materials that could damage the metal jacket.
* Do not wear jewelry or other materials that could trap liquid to the skin if spilled. (A spill or splash could freeze the jewelry to your skin.)
* Handle and store cylinders in an upright position.

**2.3 Personal Protective Equipment (PPE):**

* Safety Goggles
* Face Shield
* Cryogenic Resistant Gloves (Gloves should be loose enough to easily toss off in the event of a spill on the gloves. Remember, these gloves only provide short-term protection against accidental skin exposures and are not designed to protect skin against prolonged contact.)
* Laboratory Coat
* Closed Toe Shoes and Pants

**3.0 Special Precautions for Dispensing and Transporting Cryogenic Liquids:**

Special precautions must be taken to prevent a spill while dispensing or transporting cryogens in addition to minimizing exposures from liquids and vapors. The high liquid to vapor expansion ratio could rapidly displace all oxygen in a room and result in asphyxiation. Implement the following procedures to minimize exposure:

* Wear proper PPE.
* Use a dewar or storage vessel rated for the cryogen you are refilling or transporting.
* Use only fitted transfer tubes designed for use with the dewar container. Cracked or damaged insulation on transfer tubes should be replaced. Do not handle transfer tubes with bare hands, since the fitting is not insulated.
* Do not use rubber or plastic tubing to transfer cryogens. The temperature can cause rubber or plastic tubing to become brittle and crack.
* Only fill a dewar from a transfer line that has a phase separator attached to the end of the line.
	+ When filling a dewar flask at a filling station, place the phase separator so that it rests on the bottom of the dewar. Do not allow the cryogen to splash into the dewar.
* When obtaining liquid from a large dispensing dewar or cylinder, cool the secondary container by adding a little cryogenic liquid first. Dispense slowly to mitigate thermal stress, stay in constant attendance of the filling operation, do not overfill, and do not allow the cryogenic liquid to fall through a distance to reach the receiving vessel.
* When manually pouring liquid into a smaller dewar, assure that the secondary container is secured, pour slowly to prevent excess splashing, and do not overfill.
* Use handcarts equipped with brakes for transporting large dewars and cylinders.
* Use at least two personnel to transport large dewars.
* Avoid traveling in an elevator with a dewar. Spills or elevator failures may be dangerous in this restricted space by displacing oxygen if the cylinder failed or leaked. If this is not avoidable, make sure to use the buddy system and have another employee remain outside the elevator during transport.
* When carrying a dewar, wear PPE and hold the dewar as far away from the face as possible. Containers that cannot be easily and safely carried should be placed on a stable wheeled base designed for the dewar.

**4.0 Storage:**

A cryogenic liquid storage unit left open to the atmosphere, or catastrophic failure of a storage unit, could create an oxygen deficient atmosphere. Follow these procedures to reduce the likelihood of this occurrence:

* Glass dewars must have an exterior coating/cover to minimize projectiles in the event of an explosion. Newer dewars may have a plastic mesh over the exterior for this purpose. Older dewars must be thoroughly taped or replaced.
* Only store dewars in well-ventilated rooms with a minimum of six air changes per hour.
* If the ventilation rate is unknown, contact EHS to evaluate the storage area.
* EHS may recommend the installation of oxygen detection systems and alarms for cryogenic liquid storage areas depending on location, ventilation, and quantity of material stored.
* Do not store cryogenic liquids with corrosive or flammable chemicals.
* Storage units should be placed so that vents and openings are oriented away from personnel and lab equipment.
* Bulk cryogenic liquid dispensing areas within buildings must be well ventilated. EHS recommends continuous oxygen monitoring equipment in all these areas. All new installations should be designed with an oxygen monitoring system and alarm.
* Storage of cryogenic liquid dewars in hallways, unventilated closets, environmental rooms, and stairwells is prohibited.
* No more than one back-up dewar is allowed per piece of equipment using cryogenic liquids in research labs. Additional dewars must be stored in areas designed for such storage. Contact EHS at extension 42618 to evaluate potential storage locations.

**5.0 Emergency Procedures:**

 **5.1** Implement the following procedures to minimize the risk of asphyxiation:

* Periodic equipment inspections, removal of ice blockages, and replacement of damaged or old storage units will reduce the probability of the catastrophic failure of a storage unit. Ice blockages that prevent the container from venting properly can cause an explosion hazard. Contact EHS immediately at extension 42618 if ice blockages are observed.
* If ventilation in the room is less than six air changes per hour or if dewars are not in a vented enclosure, contact EHS about installing an oxygen level detection alarm.
* If a spill occurs, immediately exit the area. With adequate ventilation, it may be appropriate to return to the area after thirty minutes. For large spills, contact EHS immediately to monitor oxygen levels in the area and determine when it is safe to re-enter.
* Once you have evacuated the lab, post a restriction on the lab door and call extension 44911.
* If experiencing symptoms such as lightheadedness, dizziness, or confusion, immediately seek fresh air and receive medical attention.
* If an employee becomes unconscious in a cryogenic liquid storage area, they should only be retrieved by personnel using proper PPE (such as a Self- Contained Breathing Apparatus). UMass Lowell campus police should be immediately notified at extension 44911 to coordinate emergency rescue services. (Over fifty percent of deaths associated with asphyxiation in confined spaces occur to would-be rescuers.)
	+ Once personnel have been removed to fresh air, provide rescue breathing or CPR until paramedics arrive.

**5.2** For skin and eye exposure to cryogenic gases or liquids, follow first aid procedures and seek medical attention:

* Immediately remove any clothing that has been contaminated. In the event of clothing contamination with oxygen, hydrogen, or carbon monoxide; it is important to remove clothing, evacuate personnel from the facility, and keep away from ignition sources.
* Call extension 44911. (The buddy should call extension 44911 while you are removing contaminating clothing.)
* Flush or soak the area with warm water (no greater than 105 degrees Fahrenheit)
* Do not apply dry heat or rub damaged flesh or eyes.
* Do not apply heat lamps or hot water and do not break blisters.
* Employees should notify their supervisor of injuries and receive medical attention.

**5.3** For fire:

* Evacuate the lab, pull the nearest fire alarm pull station and then go to a safe area and call extension 44911. Follow the fire safety evacuation plan.

**NOTE:** All work-related injuries must be reported immediately to Human Resources (HR) by calling extension 43560. An Incident/Injury Report Form must be filled out and faxed to EEM-EHS at 934-4018. [The Incident/Injury Report Form is available on-line at <http://www.uml.edu/ehs>. Please double click on the link at the end of this web page entitled [UMass Lowell Emergency Accident / Incident Report Form (PDF).]](http://www.uml.edu/ehs/Documents/UMass_Lowell_Emergency_Accident-%20Incident_%20Report_%20Form.pdf)

The original Incident/Injury Report Form must be turned in to HR.

*\*The buddy, supervisor, or Principal Investigator may fill out the Incident/Injury Report Form while the injured employee follows first aid procedures and seeks medical attention.*

**6.0 Related Documents:**

Compressed Gas Association (CGA) P-12-1993, *Safe Handling of Cryogenic Liquids*

 CGA S-1.1, Pressure Relief Device Standards – Part 1 – *Cylinders for Compressed Gases*

CGA S-1.2, Pressure Relief Device Standards – Part 2 – *Cargo and Portable Tanks for Compressed Gases*

CGA S-1.3, Pressure Relief Device Standards – Part 3 – Compressed Gas Storage Containers

CGA V-1, American National, Canadian, and Compressed Gas Association Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections

OSHA 1910.106 Flammable Liquid Storage

ASME Boiler and Pressure Vessels Code Section VIII, Division 1, NFPA 45, *Fire Protection for Laboratories Using Chemicals*

NFPA 45, *Flammable and Combustible Liquids Code*

NFPA 50, *Standard for Bulk Oxygen Systems at Consumer Sites*

NFPA 50B, *Standard for Bulk Hydrogen Systems at Consumer Sites*