

Beaumont

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Safe Use and Handling of Cryogenic Materials

Document Type: Policy

I. PURPOSE AND OBJECTIVE:

Working with cryogenic liquids involves significant health and safety hazards. This policy identifies health hazards, safe work methods, safe handling, transport, storage, and emergency spill response information to assist personnel with reducing the risk of working with cryogenic liquids.

II. POLICY STATEMENT:

It is the policy of Beaumont Health to comply with all local, state, and federal laws governing the safe handling, storage and use of cryogenic materials.

III. DEFINITIONS:

Cryogenic liquids are extremely cold liquids that at normal temperature and pressure would be a gas. These very cold liquids provide a fluid media that is useful for researchers to preserve their sample materials and for laboratory experimental processes.

The term "cryogenic" means producing, or related to low temperatures. Cryogenic liquids are liquefied gases that are kept in their liquid state at very low temperatures. These liquids have boiling points below -238° F (-150° C) and are gases at normal temperatures and pressures. Different cryogens become liquids under different conditions of temperature and pressure, but all have two common properties: they are extremely cold and small amounts of the liquid can expand into very large volumes of gas.

Most cryogenic liquids and the gases they produce can be placed into one of three groups:

- **Inert gases** – These gases do not react chemically to any great extent and do not burn or support combustion. Examples of this group are nitrogen, helium, neon, argon and krypton.
- **Flammable gases** – Some cryogenic liquids produce a gas that can burn in air. The most common examples are hydrogen, methane and liquefied natural gas.
- **Oxygen** – Many materials considered as non-combustible can burn in the presence of liquid oxygen. Organic materials can react explosively with liquid oxygen.

IV. LOCATION OF USE:

- Anatomic Pathology
- Clinical Pathology
- Research

- Cytogenetics

V. SELECTION PROCESS:

- A. Only cryogenic fluids currently used within these departments will be ordered.
- B. Amounts ordered shall be the smallest quantity's needed.

VI. CRYOGEN HAZARDS:

- A. **Burns**- Direct contact of skin and cryogenic liquids can cause cold burns and frost-bite. Prolonged contact may result in blood clots.
- B. **Adhesion** - The cold surface of equipment and piping containing cryogenic liquid can cause the skin to stick to the surface, which will then tear as you attempt to remove it. Even non-metallic materials are dangerous to touch at such low temperatures.
- C. **Boiling and Splashing** - Cryogenic liquids can boil and splash when first added to a warm container.
- D. **Oxygen Deficiency and Asphyxiation** - Cryogenic liquids have the potential to create an oxygen deficient environment because of their large liquid-to-gas volume displacement ratios, typically about 700:1.
- E. **Pressure and Explosions**-Large liquid-to-gas ratios can lead to rapid pressure changes as cryogenic liquids vaporize. All cryogens can condense sufficient moisture from the air subsequently freezing and blocking the opening of storage vessels. This can lead to an explosion from the buildup of trapped gases in the container; for instance, cryo-tubes stored in liquid nitrogen may explode when removed from the Dewar.
- F. **Flammability and Explosions** - Nitrogen and helium are considered non-reactive and non-flammable; however, liquid nitrogen and liquid helium can condense oxygen out of air. Liquid oxygen is VERY reactive and hazardous. Combustible substances exposed to liquid oxygen becomes more likely to ignite, will burn more vigorously, and may potentially explode. Materials usually considered non-flammable can burn vigorously in an oxygen enriched environment. Organic materials that can react violently with liquid oxygen include oil, grease, kerosene, tar, cloth, and asphalt. Any planned use with liquid oxygen should be reviewed and approved by the Corporate Safety Department.

VII. PHYSICAL EFFECTS OF CRYOGENS:

- A. The extreme temperatures of cryogenic liquids cause most solids to become more brittle. Materials such as carbon steel, plastics and rubber should not be used with cryogenic liquids because they can fracture or shatter extremely easily.
- B. Materials that are usually considered non-combustible, such as aluminum, carbon steel, cast iron, stainless steel and zinc may burn in the presence of liquid oxygen.
- C. Without adequate ventilation or pressure-relief devices on cryogenic containers, enormous pressure can build up. The pressure can cause a Boiling Liquid Expanding Vapor Explosion (BLEVE).

VIII. HEALTH HAZARDS OF CYROGENS:

There are three groups of health hazards associated with cryogenic liquids – extreme cold, asphyxiation and toxicity.

- A. **Extreme cold:** Contact with cryogenic liquids and their cold gases can produce effects on the skin similar to a thermal burn. Brief exposures that may not affect the hands can damage delicate tissues such as the eyes. Prolonged exposure of the skin or contact with cold surfaces can cause frostbite. Tissues that have been frozen will be painless while still frozen and might look waxy yellow. Thawed frostbitten skin will be very

painful, red and swollen and can become infected. Unprotected skin can stick to materials that are cooled by cryogenic liquids. However, where cryogenics are involved, metallic materials are not the only ones that cause this risk. It is important to remember that even nonmetallic materials are extremely dangerous to touch. Removing skin from any material can cause a tearing of the flesh.

- B. **Asphyxiation:** Prolonged breathing of extremely cold air may damage the lungs. Also, when cryogenic liquids form a gas, the gas is very cold and usually heavier than air. The cold, heavy gas does not disperse well, tends to accumulate near the floor and displaces air. When there is not enough air, asphyxiation and death can occur. This is a serious hazard especially in enclosed or confined spaces.
- C. **Toxicity:** Small amounts of cryogenic liquids can evaporate into very large volumes of gas. For example, one liter of liquid nitrogen vaporizes into 695 liters of nitrogen gas when warmed to room temperature. Each cryogenic liquid/gas can cause specific health effects. Refer to the manufacturer's Safety Data Sheet (SDS) for information about the toxic hazards of a specific cryogen.

IX. SAFE HANDLING PROCEDURE:

- A. Be familiar with hazards associated with cryogen use.
- B. Work in an open, well-ventilated location. Consider ventilation monitors or oxygen deficient sensors and alarms. Check the monitors and alarms before and during cryogen use.
- C. Never use in a small poorly ventilated room, and never dispose of liquid nitrogen by pouring it on the floor. It could displace enough oxygen to cause suffocation.
- D. Always wear safety goggles and/or face shield.
- E. Always wear appropriate cryogen gloves; do not leave skin exposed. Do not wear metal jewelry or watches.
- F. Examine containers and pressure relief valves for signs of defect. Never use a container that has defects.
- G. Dewars are open, non-pressurized and manufacturer approved vessels for holding cryogenic liquids. (A Thermos™ bottle type container is not appropriate for the storage or transport of cryogenic materials and shall not be used) Only containers that are rated for the storage of cryogenic materials "Dewars" will be utilized.
- H. Ensure that equipment and containers are free of oil, grease, dirt, or other materials which may lead to flammability hazard upon contact with liquid oxygen.
- I. Select working materials carefully. Cold cryogenic liquids may alter the physical characteristics of many materials, make them brittle and fail.
- J. Areas which use cryogenic fluids will be equipped with:
 - 1. Approved automatic sprinkler system.
 - 2. Mechanical exhaust ventilation to capture fumes or vapors.
 - 3. Personal Protective Equipment to be worn while handling include:
 - 4. Heavy insulated gloves
 - 5. Chemical Goggles or a Full Face Shield
 - 6. Long sleeve clothing, lab coat, fluid resistant gown, leather or cryo-apron preferred while handling
- K. The aggregate quantity in use and storage shall not exceed the quantity listed for storage.
- L. Rooms/Areas used for the storage of liquid nitrogen shall have appropriate warning signage placed at a minimum on the exterior of the entry door. Additional signage may be added at the location of the storage Dewar. Signs are available commercially from companies such as:
 - [Smart Sign](https://www.smartsign.com/SMT/QS/liquid_nitrogen.aspx) https://www.smartsign.com/SMT/QS/liquid_nitrogen.aspx

- [Safety Sign](https://www.safetysign.com) <https://www.safetysign.com>
- [Seaton](https://www.seton.com/signs/safety) <https://www.seton.com/signs/safety>
- [Emedco](https://www.emedco.com) <https://www.emedco.com>



- M. Additional signage requirements: Per the International Fire Code; an NFPA 704 diamond is required where cryogenic fluids are used or stored under the given quantities:
- Flammable: > 1 gallon (Contact Corporate Safety for guidance)
 - Inert: 60 gallons or more (Liquid Nitrogen 3-0-0-SA, See NFPA diamond below)
 - Oxidizing including Oxygen: 10 gallons or more (Liquid Oxygen 3-0-0-OX, See NFPA Diamond below)
 - Other physical or health hazard: any amount. (Contact Corporate Safety for guidance)



N. Transfer and Use:

1. All cryogenic systems and Dewars must have pressure relief valves to release excessive pressure, and bursting discs and loose fitting lids on Dewar flasks. The pressure relief valves should be inspected regularly.
2. Use only fitted transfer tubes designed for use with the Dewar container. Damaged transfer tubes should

be replaced. Do not handle transfer tubes with your bare hands as the fitting is not insulated.

3. When transferring to a secondary container, do not fill the secondary container to more than 80% of capacity (60% if the temperature is likely to be above 30°C).
4. Do not lower warm experiments into Dewars of cryogen. Immediately re-cap any container to prevent atmospheric moisture from entering and forming an ice plug in the opening.
5. Provide proper venting for the Dewars used in experiments.
6. Use care in transporting cryogenics; do not use fragile containers. Use a hand truck or the lowest shelf of a cart for transport of cryogenics. When available, use service elevators for transferring unsealed containers of cryogenics.
7. Cryogenic liquids should not be handled in open pail-type containers or in unapproved container; Use only approved containers.
8. Transfer of liquid into warm lines or containers must be done slowly to prevent thermal shock and possible buildup of pressure.
9. Avoid rough handling of liquid containers.
10. Liquid cylinders should only be moved with proper handling equipment.
11. Prior to use, ensure the fittings on the regulator match the fittings on the liquid container
12. Never use unapproved adapters to withdraw cryogenics.
13. Never attempt to change or remove any fittings.
14. Never plug, restrict, or remove any relief device.
15. Never attempt to cap or seal a venting relief device in any way. Ice or frost buildup on a pressure relief valve can be removed with a damp cloth. (Wear proper Personal Protective Equipment (PPE) when removing the frost.)

O. Storage:

1. Store cryogenics in well-ventilated areas to prevent oxygen deficiency.
 - a. Because of the large expansion ratio of liquid to gas (1:696), it is important to provide adequate ventilation in areas using liquid nitrogen. A minimum of six air changes per hour is required in these areas.
 - b. Oxygen level monitoring should be provided for areas where oxygen displacement may occur.
 - c. OSHA has established 19.5% oxygen concentration as the minimum for working without supplied air.
 - d. In areas where liquid nitrogen (LN2) is used, per GEN.77550 Liquid Nitrogen Environmental Monitoring; laboratories must:
 - i. Use oxygen sensors with a low oxygen alarm
 - ii. Place alarms at breathing height in areas close to where LN2 is used or where a leak would occur
 - iii. Have sufficient airflow to prevent asphyxiation
2. Use only approved storage vessels that have pressure relief valves.
3. Never adjust, block, or plug a pressure relief valve. The vendor is required to check the pressure relief valve before filling the Dewar.
4. Avoid contact of moisture with storage containers to prevent ice plugs in relief devices.

5. Periodically check container necks for ice plugs; core out ice plugs if present.
6. Keep all heat sources away from cryogenic liquids.
7. Do not use cryogenics or dry ice in walk-in cold rooms, because they may not have sufficient air exchange and could become hazardously oxygen deficient.

P. All Dewars/Containers shall be Labeled to include:

1. Manufacturer name, with product order number
2. Chemical identification name with Formula
3. All additional hazard and disposal information as provided by manufacturer or distributor.

Q. Cryogenics shall be stored:

1. Cryogenics shall be stored in containers in compliance with recognized standards of design and construction for specific cryogenic fluids.
2. Shall be stored in an upright position.
3. Pressure relief valves shall be located such that they provide easy access.
4. Valve caps, if provided, shall be in place.

R. Cryogenic containers shall be secured against accidental dislodgement.

1. Containers shall be secured by a chain to the wall.
2. All piping, valves and pressure release devices shall be protected against physical damage and tampering.
3. Containers shall not be stored near stairs, elevators, exit routes.

S. Cryogenic containers shall be separated from other materials and conditions that pose exposure hazards to each other:

1. Minimum 1 foot from wall openings.
2. Minimum 10 feet from air intakes
3. Minimum 3 feet from area exits

T. Floor under the container must be:

1. Solid and able to withstand the weight of the container
2. Level, to avoid tipping of container
3. Compatible with the contents of the container

U. The aggregate quantity in use and storage of flammable and oxidizing cryogenic liquids shall not exceed the quantity listed for storage; this applies to ground floor storage, and one floor above ground locations only in fully sprinklered buildings; for other locations please contact the Corporate Safety Department for guidance. Inert cryogenic fluids do not have a limit for storage or use.

1. Amount:

a. **Cryogenic, flammable**

Storage: 90 gallons

In-Use: 20 gallons

b. **Cryogenic, oxidizing**

Storage: 90 gallons

In-Use: 20 gallons

X. PERSONAL PROTECTIVE EQUIPMENT:

A. Hand Protection:

1. Wear loose fitting gloves made for cryogenic work (blue cryogenic gloves) or smooth leather welding type gloves without gauntlets. Loose fitting gloves can be thrown off if some cryogen leaks or is spilled into them.
2. Rubber gloves should not be used because they will harden instantly - if your hand is bent, you may not be able to remove your hand.
3. A thin gas barrier forms between the skin and the cryogenic liquid when it is spilled on the skin. This will protect you unless the liquid hits you under force. This gas barrier is very cold and can also burn you.
4. Use non-metallic tongs to add or remove materials from cryogenic liquids.

B. Eye Protection:

1. Face shields and goggles provide the best protection for the eyes and face. Safety glasses will not protect your face, and cold liquids can hit your face and run under the glasses into your eyes.
2. Goggles and faceshields are both acceptable although faceshields are preferred when filling dewars or transferring liquids for the highest level of protection
3. Avoid working with cryogenics overhead, as a spill can more likely result in serious injury. Extra care should be taken when working with cryogenics overhead, such as when filling lab equipment. If necessary, use a ladder and work from above with no one below.

C. Clothing:

1. Closed toe shoes are required when handling cryogenic liquids. Leather will shed the spilled liquid. Cuff less pants should cover the shoe top. Sneakers are typically made with absorbent materials which could draw liquid toward your skin and therefore should not be used.
2. Long sleeve shirts made of non-absorbent material are best.
3. Long sleeve clothing, lab coat, fluid resistant gown, leather or cryo-apron preferred while handling and when working with liquid cryogenics. Most clothing material will absorb spilled liquid cryogenics, bringing the liquid close to the skin.

XI. TRANSPORTATION:

- A. All applicable Department of Transportation (DOT) regulations will be followed.
- B. Transport all cylinders on equipment designed for this function. Never "walk" cylinders by hand.
- C. Always push Dewars if they need to be moved. Never pull on Dewars - they are very heavy and can tip and crush you. Large Dewars can lead to ergonomic injuries (back injuries, crushed foot, crushed hand).
- D. Liquid cylinders range in different weights and sizes. They are heavy and cumbersome, especially when filled with liquid nitrogen.
- E. They may require for two people to handle in order to do so safely.
- F. Containers can cause crushing injury to the feet. Wear proper shoes. Tennis shoes and open toed shoes are not proper foot protection.

XII. MONITORING:

- A. Proper storage and use of cryogenic solutions will be monitored by periodic safety inspections, completed by

the safety committees during hazard surveillance rounds on each campus utilizing cryogenic materials.

- B. Containers will be inspected for leaks, damage and corrosion.
- C. If found to be unserviceable, the containers will be replaced immediately.

XIII. DISPOSAL:

- A. Containers that are empty will be removed by licensed cryogenic fluid vendor.
- B. Do NOT empty container by opening valves and releasing cryogenic fluid into the room.
 - 1. Unused cryogenic liquids should be left to evaporate away in a well ventilated area away from work spaces and foot travel
- C. Do NOT pour Cryogenes down drains.

XIV. EMERGENCY PROCEDURES:

- A. Some cryogenic fluids if released in gas form in small spaces can displace or remove/replace oxygen from the atmosphere causing an asphyxiation hazard without warning. Areas that have been properly evaluated where oxygen displacement can occur should be equipped with the following:
 - 1. Room shall have an oxygen monitor installed outside the room.
 - 2. Room shall have audio and flashing light alarm, when oxygen levels are below acceptable limits.
 - 3. If the alarm sounds, only personnel trained and equipped with Self-Contained Breathing Apparatus (SCBA), with a back-up person, will be allowed to enter the area.
- B. Bulk Container Emergencies
 - 1. If there is a large spill or rupture of a container, call 911, warn others in the area or building
 - 2. Evacuate the area immediately. There may be an oxygen deficiency in the area of the spill.
 - 3. If there is injury to the body from liquid nitrogen, seek immediate medical assistance.

XV. INJURIES:

- A. If skin comes into contact with a cryogen, run the area under tepid water for fifteen minutes. Never use hot or cold water. The re-warming, or thawing, of affected area(s) should be done gradually. It may take up to 60 minutes to thaw the affected area(s) and bring back the natural color of the skin.
- B. If your finger is burned, do not put it in your mouth. This could burn your mouth or tongue.
- C. Do not rub a burned area: rubbing can cause further tissue damage.
- D. Always seek medical attention for frostbite injuries. You should obtain medical assistance as soon as possible when cryogenes contact your skin. Immediately, upon exposure, the frozen skin appears waxy and yellow and the burn usually is not painful. Then it painfully swells and blisters while the skin defrosts.
- E. Notify your supervisor immediately of any or injury due to cryogen exposure.

XVI. ORIENTATION / EDUCATION:

- A. Personnel shall receive instruction concerning chemicals:
 - 1. Before assuming responsibilities
 - 2. During refresher training
 - 3. When there is a significant change in duties, regulations, or type of chemicals used

- B. Safety Data Sheets (SDS) are available, via [MSDS On-Line](#)
- C. Staff utilizing Liquid Nitrogen/Cryogenics should complete the Safe Handling and Use of Liquid Nitrogen Module on Healthstream prior to working with cryogenic materials.

Attachments

No Attachments

Approval Signatures

Step Description	Approver	Date
VP Support Services	John Fragomeni: VP Support Services	2/8/2021
Policy and Forms Steering Committee Approval (if needed)	Gail Juleff: Project Mgr Policy	2/8/2021
Policy and Forms Steering Committee Approval (if needed)	Amy Blazejewski: Sr Dir, Env & Life Safety	2/8/2021
	Timothy Poszywak: Mgr, Construction Compliance	2/8/2021
	Amy Blazejewski: Sr Dir, Env & Life Safety	2/8/2021
	Amy Blazejewski: Sr Dir, Env & Life Safety	2/8/2021

Applicability

Beaumont Corporate Shared Services, Beaumont Medical Group, Beaumont Pharmacy Solutions, Dearborn, Farmington Hills, Grosse Pointe, Post Acute Care, Royal Oak, Taylor, Trenton, Troy, Wayne