DUQUESNE UNIVERSITY

Liquid Nitrogen Safety

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**Introduction**
The safe handling and use of liquid nitrogen in liquid nitrogen dewars or flasks is possible only by knowing the potential hazards and using common-sense procedures based on that knowledge. There are two important properties of liquid nitrogen that present potential hazards:

1. It is extremely cold. At atmospheric pressure, liquid nitrogen boils at -320F/196C.
2. Very small amounts of liquid vaporize into large amounts of gas. One liter of liquid nitrogen becomes 24.6 ft^3/0.7 m^3 of gas.

The safety precautions as outlined must be followed to avoid potential injury or damage which could result from these two characteristics. Do not attempt to handle liquid nitrogen until you read and fully understand the potential hazards, their consequences, and the related safety precautions.

**Handling Liquid Nitrogen**
Contact of liquid nitrogen, or any very cold gas, with the skin or eyes may cause serious freezing (frostbite) injury. Protect hands at all times when working with liquid nitrogen with Cryo gloves.

Handle Liquid Nitrogen Carefully. The extremely low temperature can freeze human flesh very rapidly. When spilled on a surface the liquid tends to cover it completely and intimately, cooling a large area. The gas issuing from the liquid is also extremely cold. Delicate tissue, such as that of the eyes, can be damaged by an exposure to the cold gas which would be too brief to affect the skin of the hands or face.

Never allow any unprotected part of your body touch objects cooled by liquid nitrogen. Such objects may stick fast to the skin and tear the flesh when you attempt to free yourself. Use tongs, preferably with insulated handles, to withdraw objects immersed in the liquid, and handle the object carefully.

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Wear protective clothing. Protect your eyes with a face shield or safety goggles (safety glasses without side shields do not give adequate protection). Always wear cryo gloves when handling anything that is, or may have been, in immediate contact with liquid nitrogen. The gloves should fit loosely, so that they can be thrown off quickly if liquid should splash into them. When handling liquid in open containers, it is advisable to wear high-top shoes. Trousers (which should be cuffless if possible) should be worn outside the shoes. Any kind of canvas shoes should be avoided because a liquid nitrogen spill can be taken up by the canvas resulting in a far more severe burn. A lab coat should also be worn.

Use only containers designed for low-temperature liquids. Cryogenic containers are specifically designed and made of materials that can withstand the rapid changes and extreme temperature differences encountered in working with liquid nitrogen. Even these special containers should be filled slowly to minimize the internal stresses that occur when any material is cooled. Excessive internal stresses can damage the container.

Do not ever cover or plug the entrance opening of any liquid nitrogen dewar. Do not use any stopper or other device that would interfere with venting of gas.

These cryogenic liquid containers are generally designed to operate with little or no internal pressure. Inadequate venting can result in excessive gas pressure which could damage or burst the container. Use only the loose-fitting necktube core supplied or one of the approved accessories for closing the necktube. Check the unit periodically to be sure that venting is not restricted by accumulated ice or frost.
Use proper transport equipment. Use a phase separator or special filling funnel to prevent splashing and spilling when transferring liquid nitrogen into or from a dewar. The top of the funnel should be partly covered to reduce splashing. Use only small, easily handled dewars for pouring liquid. For the larger, heavier containers, use a cryogenic liquid withdrawal device to transfer liquid from one container to another. Be sure to follow instructions supplied with the withdrawal device. When liquid cylinders or other large storage containers are used for filling, follow the instructions supplied with those units and their accessories.

Do not overfill containers. Filling above the bottom of the necktube (or specified maximum level) can result in overflow and spillage of liquid when the necktube core or cover is placed in the opening.

Never use hollow rods or tubes as dipsticks. When a warm tube is inserted into liquid nitrogen, liquid will spout from the bottom of the tube due to gasification and rapid expansion of liquid inside the tube. Wooden or solid metal dipsticks are recommended; avoid using plastics that may become very brittle at cryogenic temperatures which then become prone to shatter like a fragile piece of glass.

Nitrogen gas can cause suffocation without warning. Store and use liquid nitrogen only in a well ventilated place. As the liquid evaporates, the resulting gas tends to displace the normal air from the area. In closed areas, excessive amounts of nitrogen gas reduce the concentration of oxygen and can result in asphyxiation. Because nitrogen gas is colorless, odorless and tasteless, it cannot be detected by the human senses and will be breathed as if it were air. Breathing an atmosphere that contains less than 19 percent oxygen can cause dizziness and quickly result in unconsciousness and death.

Note: The cloudy vapor that appears when liquid nitrogen is exposed to the air is condensed moisture, not the gas itself. The gas actually causing the condensation and freezing is completely invisible.

Never dispose of liquid nitrogen in confined areas or places where others may enter.

Disposal of liquid nitrogen should be done outdoors in a safe place. Pour the liquid slowly on gravel or bare earth where it can evaporate without causing damage. Do not pour the liquid on the pavement.

Handling liquid nitrogen dewars. Keep unit upright at all times except when pouring liquid from dewars specifically designed for that purpose. Tipping the container or laying it on its side can cause spillage of liquid nitrogen. It may also damage the container and any materials stored in it. If tipping is anticipated, be sure to purchase a dewar that can be outfitted with a tipping stand.

Rough handling can cause serious damage to dewars. Dropping the container, allowing it to fall over on its side, or subjecting it to sharp impact or severe vibration can result in partial or complete loss of vacuum. To protect the vacuum insulation system, handle containers carefully.
Do not "walk", roll or drag these units across a floor. Use a dolly or handcart when moving containers, especially the larger dewars. Large units are heavy enough to cause personal injury or damage to equipment if proper lifting and handling techniques are not used.

**When transporting a liquid nitrogen dewar, maintain adequate ventilation and protect the unit from damage.** Do not place these units in closed vehicles where the nitrogen gas that is continuously vented from unit can accumulate. Prevent spillage of liquids and damage to unit by securing it in the upright position so that it cannot be tipped over. Protect the unit from severe jolting and impact that could cause damage, especially to the vacuum seal.

**Transporting by hand or cart through a building or between buildings.** Inside buildings, from room to room, the best transport is by dewars which either have carrying handles (4 L and less) or are on wheels, and which have pressure relief valves or pressure venting lids.

For short distances in hallways it is acceptable to hand-carry a pint (~500 mL) or smaller dewar of nitrogen which has no handles, if and only if

- The dewar is you only load (no books, no coffee, no other items), and
- The vessel has a venting lid (a cork or loose stopper is fine), and
- You are carefully watching for people who could run into you, and
- The vessel is carried with both hands and as far away from your face as comfortably possible.

Transport of any dewar by Duquesne University employees in any elevator should be limited and conducted only when necessary. Two individuals must be present when transporting dewars on the elevator, one stationed at the each floor to ensure that no one enters the elevator until the dewar reaches its destination floor. The ventilation switch inside the elevator should be activated as well.

**Keep the unit clean and dry.** Do not store it in wet, dirty areas. Moisture, animal waste, chemicals, strong cleaning agents and other substances which could promote corrosion 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.

**Protect dewar contents.** Materials stored in a liquid nitrogen dewar with a wide mouth are protected by the extremely low temperature of the liquid nitrogen or the gas that issues from the evaporating liquid nitrogen. When all of the liquid nitrogen has evaporated, the temperature inside the unit will rise slowly to ambient. The rate at which the liquid nitrogen will evaporate depends upon the pattern of container use and the age and condition of the container. Evaporation increases as insulation efficiency deteriorates with age and rough handling. Opening and closing to insert and remove materials and moving the unit will also increase the evaporation rate.
**First Aid Notice**

Contact Campus Police at x2677 (COPS).

If a person seems to become dizzy or loses consciousness while working with liquid nitrogen, move to a well-ventilated area immediately. If breathing has stopped, apply artificial respiration. If breathing is difficult, give oxygen. Keep warm and at rest.

If exposed to liquid or cold gas, restore tissue to normal body temperature 98.6°F (37°C) as rapidly as possible, followed by protection of the injured tissue from further damage and infection. Remove or loosen clothing that may constrict blood circulation to the frozen area. Call a physician. Rapid warming of the affected part is best achieved by using water at 108°F/42°C. Under no circumstances should the water be over 112°F/44°C, nor should the frozen part be rubbed either before or after rewarming. The patient should neither smoke, nor drink alcohol.

Most liquid nitrogen burns are really bad cases of frostbite. We don't mean to belittle the harm that can come from frostbite, but at the same time, we wanted to keep the dangers associated with liquid nitrogen burns in perspective. Indeed, liquid nitrogen burns could be treated as frostbite.