



Hudson Valley Community College Liquid Nitrogen Safety Guidelines

INTRODUCTION

Nitrogen makes up the major portion of the atmosphere (78% by volume). Nitrogen is inert and will not support combustion; however, it is an asphyxiant that does not provide the oxygen necessary to support life. When gaseous nitrogen is converted to liquid form it becomes a cryogenic liquid.

Cryogenic liquids are liquefied gases with a boiling point below -150°C (-238°F) that are kept in their liquid state at extremely low temperatures. Liquid nitrogen is a colorless, odorless, inert and non-toxic cryogenic liquid with a boiling point of -320°F (-196°C). Cryogenic liquids are characterized by their extremely low temperature and by their extremely high expansion rate when their physical state changes from liquid to gas.

Other examples of common cryogens include liquid helium, hydrogen, argon, oxygen and methane. Due to these characteristics, work involving cryogenics presents certain health and safety hazards. Those working with cryogenics need to be aware of such hazards and ensure they take the necessary precautions.

This document provides guidelines for the safe handling, storage and use of liquid nitrogen at Hudson Valley Community College.

HAZARD OVERVIEW

Extreme Cold Hazard

Direct skin or eye contact with cryogenic fluids (liquid or cold gas) can cause severe damage, including cryogenic burns, frostbite and eye damage. Wet skin is particularly vulnerable to freezing. Delicate tissues such as the eyes can be permanently damaged even after very brief exposures that would not affect skin on the face or hands. There is often no initial pain when tissue freezes, but there is intense pain when frozen tissue thaws. Damage can occur very quickly with only brief contact.

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.

Many substances become brittle upon contact with liquid nitrogen and may shatter when cold (such as common glass and large solid plastics), sending pieces of the material flying.

High-Pressure Gas

Working with or storing cryogenic fluids presents hazards from high-pressure gas. Due to the large expansion ratio (700:1) from liquid to gas, a build-up of high pressure can occur when the liquid evaporates. This can cause explosion of a sealed or insufficiently vented container

To prevent hazards associated with high-pressure gas, it is important to ensure that pressure relief devices are used appropriately. Common pressure relief devices found on a low-pressure liquid nitrogen cylinder are a pressure relief valve for primary protection and a rupture disc for secondary protection. When product is not being withdrawn, pressure within the cylinder will gradually increase, until the pressure relief valve activates and then reseats. This type of venting is usually normal and indicates the container is being protected from over-pressurization. Continuous venting through this valve may indicate the valve is frozen open. The rupture disc will open at a higher pressure, typically if the relief valve has failed to operate. Never plug, restrict, or remove any relief device. Never attempt to cap or seal a venting relief device in any way. These devices should be maintained and checked regularly for leaks or damage. Isolate the cylinder and notify the supplier about any container that continuously vents through any of the relief devices.

Displacement of Oxygen/Asphyxiation

Due to the large liquid to gas expansion that takes place upon evaporation, liquid nitrogen is capable of displacing sufficient oxygen to create an oxygen deficient environment in a small or insufficiently ventilated space, leading to the risk of asphyxiation.

Working in or entering an oxygen deficient atmosphere may cause unconsciousness without warning and death without regaining consciousness. If early symptoms are present, they may include but are not limited to:

- Feeling of tightness or compression in the head (near forehead)
- Tingling sensation in the tongue, fingertips and toes
- Difficulty and weakening of speech, leading to the inability to utter a sound
- Unnoticeable and then rapid reduction of the ability to exert physical effort and to coordinate movements, leading to total immobility
- Reduced awareness of the outside world and damping of sensory characteristics

It should not be presumed that any of the symptoms listed above would be felt or detected; you will not have sufficient warning.

To avoid such conditions, cryogenic liquids should only be stored, handled or used in well-ventilated areas. The greatest risk for the development of an oxygen deficient atmosphere occurs during a cryogen spill in a confined or poorly ventilated space. An oxygen monitor is present in the liquid nitrogen storage location in SCI 208. The airborne concentration of oxygen is

monitored continuously and an alarm sounds if the ambient oxygen content falls below 19.5%. You should become familiar with your monitor's alarm and if it activates, or if at any time you feel that an oxygen deficient atmosphere may exist, immediately evacuate the immediate area and notify Public Safety at x7210.

Fire and Explosion Hazards

Liquid nitrogen is not flammable. However, the boiling point of nitrogen is lower than that of oxygen, allowing oxygen to condense from the air and be concentrated. If dewars and insulated flasks containing liquid nitrogen are left uncovered and exposed to air for an extended period of time, liquid oxygen can build up to levels which may cause violent reactions with organic materials (i.e. a severe clothing fire could result).

Boiling and Splashing

Cryogenic liquids can boil and splash when first added to a warm container.

PERSONAL PROTECTIVE EQUIPMENT

All parts of the body must be protected from unintended contact with liquid nitrogen and uninsulated pipes or vessels containing cryogenic liquids. Watches, rings and jewelry should not be worn. It should be remembered that PPE is not designed to withstand immersion in, or prolonged contact with, cryogenic liquids. The following clothing and Personal Protective Equipment (PPE) is required when handling, transferring or using liquid nitrogen:

- **Face shield and unvented safety goggles.** Note: safety goggles should be worn instead of safety glasses to provide a better barrier to the entire eye in the event of a liquid splash or gas exposure. A face shield is required to protect the face from splatters of liquid nitrogen.
- **Insulated cryogenic gloves** (gloves should be loose fitting, so they can be quickly removed if liquid pours into them, or they should be elastic cuff insulated gloves).
- **Closed toe shoes** are required when handling cryogenic liquids. Leather will shed the spilled liquid. Refrain from sneakers since they are typically made with absorbent materials which could draw liquid toward your skin. Safety shoes are required when transporting cylinders.
- **Cuff-less pants** should cover the shoe top.
- **Long sleeve shirts** made of non-absorbent material are best.
- An **apron** made of leather or other non-absorbent material should be used when filling dewars or if splashing is possible. Most clothing material will absorb spilled liquid cryogenics, bringing the liquid close to the skin.

SAFE HANDLING PROCEDURES

Storage

- Store liquid nitrogen in cylinders or insulated dewar flasks which minimize the loss of product due to boil-off.
- Store in well-ventilated areas to prevent oxygen deficiency.

- Never adjust, block, or plug a pressure relief valve.
- Avoid contact of moisture with storage containers to prevent ice plugs in relief devices.
- Keep all heat sources away from cryogenic liquids.
- Do not use cryogenics or dry ice in walk-in cold rooms, because they may not have sufficient air exchanges and could become hazardously oxygen deficient.
- Pressure may build-up in liquid Nitrogen storage cylinders. Ensure all safety valves and vent valves are unobstructed and functioning properly. Check the safety vents on liquid nitrogen tanks at least twice a week.

Transport

The large low-pressure liquid nitrogen cylinders used on campus are equipped with wheels and are always rolled in their upright position. Before moving a container check to see that the wheels are firmly attached and in good condition. Cylinders should always be moved by pushing, never pulling. This reduces the possibility of the cylinder falling on you or a coworker. When transporting large liquid nitrogen cylinders you must wear steel toed safety shoes. Cylinders should be handled carefully; do not roll, drop or tip them on their sides. Extra attention should be paid to uneven floor surfaces which can catch a wheel and cause the cylinder to overturn. If you must move a cylinder over a lip or uneven surface, rotate the cylinder in circular fashion over the lip one wheel at a time.

Dewars should be capped loosely and carefully carried by the handles or placed securely on a cart for transport. 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 your 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 will run into you, and
- The vessel is carried with both hands and as far away from your face as comfortably possible.

Transport should be avoided during busy periods, i.e. in-between classes. Dewars should not be transported between floors using the stairs. Liquid nitrogen cylinders and dewars should be transported on the SCI freight elevator only. Passengers are not allowed to be on the elevator when transporting liquid nitrogen. The liquid nitrogen cylinder or cart containing the dewar should be loaded into the elevator by the user, with a sign warning others not to ride in the elevator. Before sending the elevator to the desired floor, the user must ensure that someone is at the other end to immediately receive it.

Transfer of Fluids

- All cryogenic cylinders must have pressure relief valves and burst discs to release excessive pressure. All dewars must be approved for liquid nitrogen use and have loose fitting lids.
- Use only transfer tubes designed for use with the liquid nitrogen cylinder. Damaged transfer tubes should be replaced. Do not handle transfer tubes with your bare hands as the fitting is not insulated.
- Ensure that the delivery of the liquid nitrogen is directly below the mouth of the receiving vessel; do not let the liquid nitrogen travel through a distance to reach the receiving vessel.

- Always fill dewars slowly to reduce temperature shock effects and to minimize boiling and splashing.
- When transferring to a secondary container, do not fill the secondary container to more than 80% of capacity.

Refer to Appendix A – Safe Operating Procedures for Dispensing Cryogenic Liquids from a Low Pressure Container for specific instructions on filling a dewar.

Liquid Nitrogen Use

- Be sure that all cryogen containers are clearly labeled with a cryogen warning and the cryogen's name.
- Do not directly touch or make contact with cryogenic liquids or uninsulated cryogenic equipment or pipes. Tongs can be used to withdraw objects immersed in a cryogenic liquid.
- Avoid the path of boil-off gases.
- All system vents must be directed away from personnel or designated work areas. Venting fluids (liquids or cold gases) should not impinge on any part of the body of either the worker or other personnel.
- Liquid nitrogen should never be disposed of by pouring down a drain or spilling on the floor. Any unused liquid nitrogen remaining in a dewar should be allowed to evaporate in SCI 208 or a fume hood with no other chemicals present.

SPILLS AND EMERGENCIES

Exposure

- If your skin comes in contact with liquid nitrogen, run the area of skin under cool or warm water for fifteen minutes (do not use hot or cold water). Any covering or clothing that may restrict circulation should be removed carefully, taking care not to remove skin.
- If your finger is burned do not place it in your mouth. This could burn your mouth.
- Do not rub the area; rubbing can cause further tissue damage.
- Notify your supervisor and proceed immediately College Health Services on the second floor of the Campus Center for additional treatment and assessment. For severe injuries or for off-shift assistance, contact Public Safety at x7210 or 518-629-7210 from a cell phone.

Spills

Do not attempt to clean up a spill of liquid nitrogen. Spills involving a large amount of a cryogen (especially in a confined space) can lead to a dangerously oxygen deficient atmosphere. In many cases, the best method of handling a spill is to isolate the area and allow the material to disperse over time. Personnel should be evacuated from the room and EHS contacted for assistance. Off-hours, Public Safety should be contacted for assistance.

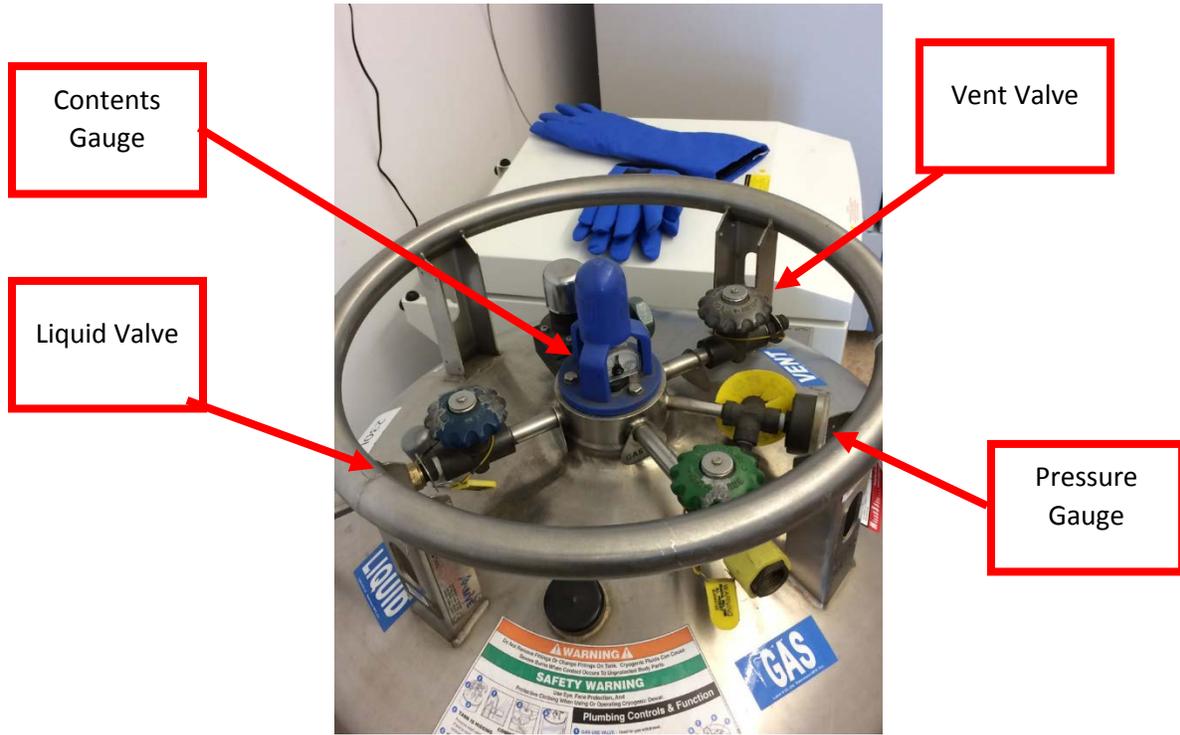
Oxygen Deficiency

In the event the oxygen monitor alarms or symptoms of oxygen deficiency are suspected, evacuate the area and contact Public Safety at x7210.

APPENDIX A

Safe Operating Procedures - Dispensing Cryogenic Liquids from a Low Pressure Cylinder

Low pressure cryogenic cylinders only dispense liquids and are typically configured as shown below:



Low pressure cylinders are equipped with the following:

- a liquid valve for dispensing liquid cryogen (it will often be blue in color),
- a vent valve for relieving excess tank pressure (it will often be silver in color),
- a burst or rupture disc for relieving excess pressure in the event the vent valve fails to operate
- a pressure gauge for determining tank pressure (often approximately 22 pounds per square inch), and
- a liquid level gauge for estimating the quantity of liquid in the cylinder.
- a gas valve may be present but will not be used for low pressure applications.

Liquid nitrogen is to be dispensed only into smaller dewars which either have carrying handles or are stable on a cart for transport. Dewars must be designed for this purpose and have a loose fitting lid to allow gas to escape.

The following procedure should be used when dispensing liquid cryogen from a low pressure container to a dewar:

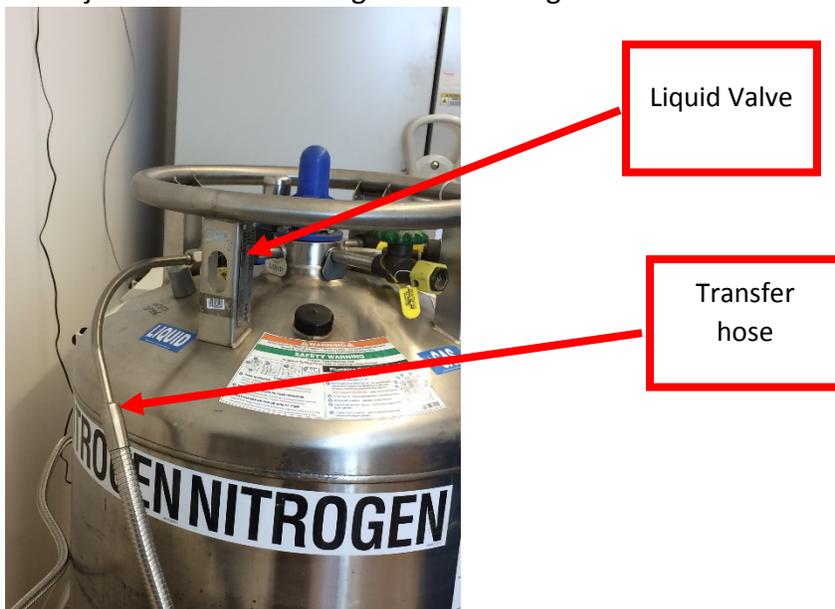
Preparation

- Ensure room is well-ventilated. All dispensing should be done in SCI 208, which is equipped with an oxygen monitor.
- Ensure dewar is labeled for contents and cryogenic warning
- Ensure Oxygen monitor reads 20.9% oxygen +/- 0.2%. If reading is outside of this range or if monitor is not functioning, contact EHS for assistance and use of a portable oxygen monitor.
- Check the pressure in the cylinder. It should read approximately 22 pounds per square inch.
- Know where the closest water is located (drench hose, safety shower)
- Protect floor from damage from spills with cardboard or carpet.
- Prop the door open.
- Check transfer hose for cracks and breaks. The transfer line should have a phase separator attached to reduce turbulence and the release of gas while filling.
- Remove jewelry (i.e. rings and watches) when working with cryogenics.
- Don appropriate clothing and PPE: Long pants and long-sleeved shirt, safety goggles, face shield, closed-toed shoes, cryogenic gloves, and cryogenic apron.

Filling

Two people must be present for the filling of dewars. Persons filling must be in constant attendance to the filling operation – DO NOT LEAVE.

- Turn off power to cryo freezer.
- Disconnect line from cylinder's liquid valve to cryo freezer.
- Place the dewar or receiving vessel on the floor mat.
- Attach the transfer hose to the liquid valve, making sure the fittings match. Use an adjustable wrench to tighten the fitting.



- Insert the transfer hose into the dewar. Place phase separator at the bottom of the dewar.
- Keep bystanders at least four feet away while filling in case of splashing.
- Open the liquid valve slowly while holding the transfer hose steady. At first you will hear gas only, continue opening valve slowly until you hear liquid begin to flow. If you fully open the valve, be sure to close it a quarter turn. A fully opened valve may freeze in that position causing a spill. A good flow rate is typically evident by a moderate vapor trail coming from the mouth of the dewar.



- When dewar is filled to required volume, close the liquid valve by turning in opposite direction.
- If liquid nitrogen level is almost overflowing the dewar, allow liquid to evaporate to an appropriate level and before capping. Do not fill more than 80% of fill capacity of the Dewar flask.
- The transfer hose will freeze during fill and will be brittle. Remove the hose carefully. Keep your foot and leg away from any cryogen that continues to spill out of the transfer hose.
- Re-connect the line feeding the cryo freezer and turn freezer back on.