

1. General precautions for all use of Liquid Nitrogen and other Cryogenic Materials:

- Liquid Nitrogen and all other Cryogenic Materials can cause significant burns. Hand protection and goggles (not safety glasses) are to be worn at all times when handling liquid nitrogen. When handling large quantities, a full length apron will minimize the chance of a spill going into your shoes, where it might destroy several cubic centimeters of flesh before you can get your shoes and socks off. Persons using a tipper to dispense liquid nitrogen and other Cryogenic Materials must wear a full face shield over goggles, cryogenic-gloves, full length trousers/pants or a full length apron, and footwear that cover the entire foot.
- Guard against pressure build-up by using a pressure relief vessel or a venting lid. Remove metallic jewelry/watches on hand and wrists.
- Glass Dewars must be taped solidly around the outside. The plastic mesh with which some small thermoses are sold protects the Dewar itself to an extent, but does not protect against injury from glass shards resulting from implosion.
- Asphyxiation -- Nitrogen is not poisonous; the air is already about 78% nitrogen (oxygen makes up about 21%, and trace gases the remaining 1%). However, if sufficient liquid nitrogen or other Cryogenic Material vaporized from a pressurized container into a poorly ventilated space it can reduce the oxygen percentage to below 20%. Personnel in that space are in critical jeopardy due to rapid oxygen deprivation. Rapid venting can cause rapid displacement of normal air, leading to a local concentration of nearly 100% nitrogen or other Cryogenic Material.
- All Cryogenic liquids produce large amounts of gas when they vaporize. If a sufficient amount of liquid is vaporized within a closed vessel it will produce enormous pressure that could rupture the vessel. For this reason, cryogenic liquid containers are protected with multiple pressure relief devices.

Expansion Ratio at 20 degrees Celsius for Common Cryogenic Fluids (Liquid to Gas)

| Cryogenic Liquid | Liters of Liquid | Liters of Gas Produced | Cubic Feet of Gas Produced |
|------------------|------------------|------------------------|----------------------------|
| Nitrogen | 1 | 696 | 24.6 |
| Oxygen | 1 | 861 | 30.4 |
| Helium | 1 | 754 | 26.6 |

- Use only vessels designed for extreme cold. **Not all Dewars are rated for liquid nitrogen or other Cryogenics!**
- Cryotubes containing samples stored under liquid nitrogen may explode without warning. Tube explosions are thought to be caused by liquid nitrogen entering the tube through minute cracks and then expanding rapidly as the tube thaws. Serious accidents can occur when a tube fails.

2. Dispensing Liquid Nitrogen and other Cryogenic Materials:

- **DO NOT transfer liquid nitrogen from high pressure outside bulk storage containers to low pressure transportable vessels or Dewar containers unless the low pressure container is fully designed and designated to accept high pressure material. Transferring high pressure nitrogen to incompatible containers is very dangerous.**
- Liquid Nitrogen and other Cryogenic Materials are to be dispensed only into smaller Dewars which either have carrying handles or are on wheels, and which have pressure relief valves or pressure venting lids. *A wide-base Dewar which is stable on a wheeled cart qualifies as "on wheels".*
- Persons filling Dewars should wear full length trousers/pants or full length apron, and footwear that covers the entire foot, along with goggles, face shield and cryo-gloves. Persons filling must be in constant awareness of the filling operation.
- To prevent splashing, place the filling hose at or below the mouth of the receiving vessel.

3. Transporting Cryogenics by hand or cart through a building or between buildings:

- Large mobile Dewars or liquid nitrogen refrigerators (or the trolleys carrying these) used for transporting cryogenics within a building or between buildings should be equipped with a braking mechanism. Do not use feet to “brake” wheels. Take care to avoid crushing hands or fingers between the vessel and walls or door frames. **Do not transport Liquid Nitrogen or other Cryogenic Materials in open containers.**
- Outside transport of wheeled vessels containing **any cryogenic material** should be undertaken by no less than two persons, and care must be taken to stay completely clear of sewer grates, large cracks in the pavement, or any other hazards which could catch the wheels and cause tipping.
- Inside buildings the best transport from room to room is by using a Dewar that is equipped with carrying handles or is on wheels, and which have pressure relief valves or pressure venting lids. *Note: A wide-base Dewar which is stable on a wheeled cart qualifies as “on wheels”.*
- For short distances in hallways it is acceptable to hand-carry **a quart or smaller** Dewar of liquid nitrogen or other Cryogenic Materials which have no handles, as long as:
 - 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
 - you are wearing appropriate PPE, and
 - the vessel is carried with both hands and as far away from your face as comfortably possible.



