

# Michigan Technological University, Department of Physics

## Liquid Nitrogen Safety

Adapted from Department of Chemical Engineering Safety Manual and:  
<http://engineering.dartmouth.edu/microengineering/ln2.html>

### Properties of Liquid Nitrogen (LN<sub>2</sub>)

1. It is extremely cold: 77.3K = -196C = -320F at atmospheric pressure. This can cause **severe frost bite**
2. On vaporization it expands by a factor of 700; one liter of liquid nitrogen becomes 24.6 cubic feet of nitrogen gas. This can cause **explosion** of a sealed container, or it can displace oxygen in the room and cause **suffocation without warning**.
3. It can become oxygen enriched and cause ordinarily noncombustible materials to burn rapidly.

### Personal Protection When Handling LN<sub>2</sub>

1. When handling LN<sub>2</sub> you should maximize the protection offered by clothing. Wear full sleeves, long pants and non-porous closed-toe shoes.
2. Splashing is common, so safety goggles or a face shield should be worn **at all times** when working with LN<sub>2</sub>.
3. Wear protective gloves when touching any object cooled by liquid nitrogen. However, the gloves should be loose fitting, so they could be thrown off if liquid were to pour inside them.
4. Care must be taken to prevent uninsulated containers from contacting unprotected skin since they may become bonded to the skin and will serious injury.
5. Contact of the skin with LN<sub>2</sub> can cause severe cryogenic burns (tissue damage is similar to frostbite or thermal burns). Although small amounts of LN<sub>2</sub> quickly evaporate when on the skin surface, if the liquid becomes trapped under jewelry, watches, or inside gloves or folds of clothing, it can result in serious and painful burns.
6. Never use LN<sub>2</sub> 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. Nitrogen gas is colorless and odorless--the cloud that forms when you pour liquid nitrogen is condensed water vapor from the air, not nitrogen gas.

### Containers for LN<sub>2</sub>

1. The properties of some materials, including metals, change drastically when exposed to cryogenic fluids such as LN<sub>2</sub>. Therefore, use only approved unsealed containers. LN<sub>2</sub> is commonly stored in Dewar flasks which should be taped to minimize hazard in the event of an implosion.
2. Never dip a hollow tube into liquid nitrogen; it may spurt liquid.
3. Never seal containers that hold LN<sub>2</sub>, they will explode.
4. Do not store liquid nitrogen for long periods in an uncovered container (on the other hand, never totally seal a container). Because the boiling point of oxygen, 90.1 K, is above that of nitrogen, oxygen can condense from the air into the liquid nitrogen. If the air over the nitrogen circulates, this liquid oxygen can build up to levels which may cause violent, highly explosive reactions with organic materials; even materials which are ordinarily nonflammable.

5. Systems including LN2 traps must never be opened to atmosphere until the trap is removed from the coolant.
6. **Never cool an apparatus under an argon atmosphere using LN2.** The boiling point of argon (-186 °C) is above that of nitrogen. Consequently, liquid argon can condense in a reaction vessel under a LN2-cooled argon environment. Should the vessel be removed or vented, it will explode because the argon will instantly vaporize and expand its volume by a factor of 847.

## Transportation and Dispensing

1. LN2 must only be dispensed into smaller Dewars which have carrying handles or are on wheels, and which have pressure relief valves or pressure venting lids.
2. When filling the Dewar, the worker should wear full length pants or full-length apron, footwear that covers the entire foot, goggles or face shield and cryo-gloves.
3. The worker must be in attendance for the entire filling period.
4. Room to room transport within buildings is best by Dewars with carrying handles (4L or less) or are on wheels (larger Dewars) with pressure relief valves or pressure venting lids. A wide-base Dewar which is stable on a wheeled cart qualifies as being "on wheels."
5. For short hallway distances, it is acceptable to hand-carry a pint (-500 mL) or smaller Dewar of LN2 with no handles if:
  - The Dewar is your only load.
  - The vessel has a venting lid.
  - You are carefully watching for people who may run into you.
  - The vessel is carried with both hands, far away from your face.

## First Aid

- Suffocation: If 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. Call a physician. Keep warm and at rest.
- Frost bite: If exposed to liquid or cold gas, restore tissue to normal body temperature, 98.6F (37 °C), 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 106 °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 re-warming. The patient should neither smoke, nor drink alcohol.

The above first aid information is from the publication "Handle With Care" ©1996 Harsco Corporation, Factory code 7950-6052.