

Liquid Nitrogen – The Unseen Danger

While working with liquid nitrogen (LN₂) can readily be done safely, it does pose risks. The obvious hazard is the extreme cold. Spilling this on you can cause cryogenic burns (similar to frostbite) so special procedures and personal protective equipment – such as a full face shield over safety glasses, loose-fitting thermal insulated or leather gloves, long-sleeved shirts or lab coats, and trousers without cuffs – should be used when handling or transferring LN₂. But liquid nitrogen has an unseen danger that is often overlooked. Imagine walking onto an elevator 6 feet by 6 feet by 8 feet with a 5 liter Dewar of LN₂. Once in the elevator, the door closes and you clumsily spill the Dewar. Not a problem, right? Well let's look a bit closer. LN₂ expands nearly 700 times its volume when it evaporates and will displace the air leaving an atmosphere of about 12% oxygen (assuming no ventilation). At these levels you will likely show symptoms of impaired judgment, perception and muscular coordination. And this is assuming the nitrogen and air mixed perfectly. Odds are that the oxygen concentration will be lower towards the floor of the elevator, so if you lose consciousness the outcome could be deadly.

This is not such a far-fetched scenario. And there are a lot of similar scenarios that can be imagined. LN₂ use is common on campus. Dewars from 50 liters to 200 liters or more can be found in most of the science and engineering buildings on campus. Under most circumstances there is little risk. Room ventilation normally handles any concerns, but are you prepared for potential asphyxiation hazards in the event of spills, leaks, or ventilation failures?

Effects of Oxygen Deficiency

Oxygen Levels (%)	Symptoms of Exposure
19.5	Minimum acceptable oxygen level.
15 to 19	Decreased ability to work strenuously. Impaired coordination. Early symptoms.
12 to 14	Breathing rate increases, increase in heart rate. Impaired coordination, perception, and judgment.
10 to 12	Breathing further increases in rate and depth, lips turn blue. Poor judgment
8 to 10	Mental failure. Fainting. Nausea Unconsciousness. Vomiting.
6 to 8	8 minutes - fatal, 6 minutes - 50% fatal, 4-5 minutes - possible recovery.
4 to 6	Coma in 40 seconds, Convulsions, Breathing stops, Death

Figure 1: Typical Symptoms of Oxygen Depletions

Nitrogen is non-toxic and makes up a bit over 78% of our atmosphere. You cannot smell, see, or otherwise detect it. The hazard with LN₂ is simply due to its displacement of oxygen. At an oxygen level of 14% and below the physiological symptoms (such as increase breathing rate and heart rate) may be detected and if a person is trained to recognize the symptoms then the appropriate steps – mainly leaving the area – can be taken. The symptoms are usually subtle, however, since you would not have the feeling of suffocating. But once the oxygen levels decrease to 12% the symptoms rapidly escalate. Below 10% the effects can be fast and lethal. In fact sporadic deaths of students and

researchers have been reported due to asphyxiation resulting from the use of LN₂. **Figure 1** describes the common symptoms of oxygen depletion. This should be used only as a guideline as underlying health conditions or individual variations can have an impact on a person's symptoms.

When we review building operations involving LN2 use we perform an analysis to see what the level of risk is. Often a worst-case scenario will still not lead to a hazardous atmosphere so no added precautions need to be taken. However if our review and calculations determine that there is a potential for significant oxygen depletion then additional steps may be required. This may be as simple as posting the room and training individuals on the hazards. Depending on the location and the use of the LN2 there may also be a need for a ventilation failure alarm or an oxygen level sensor (see **Figure 2**). In extreme cases there may be a need for special ventilation systems, personal oxygen monitors, and/or self-rescue supplied atmosphere respirators (escape packs).



Figure 2: Warning Posting for LN2 Use

Some closing points to remember:

- Liquid nitrogen should only be used and stored in a well-ventilated room.
- Make sure everyone is trained on the proper use of LN2, its hazards, and emergency procedures.
- Be aware of low-lying areas when working with LN2 since spilled or released LN2 will initially tend to accumulate near the ground.
- Never store a liquid nitrogen Dewar in a cold room. Ventilation is insufficient and even the slow off-gassing can lead to oxygen depletion.
- You should not have to rely on symptoms of oxygen depletion to know when the atmosphere in the room is not safe. This is a recipe for disaster. If there is a possibility of developing a hazardous atmosphere we can help you set up the appropriate engineering controls, alarms, and training program.

December 2012

For More Information Contact:

Environment, Health and Safety Department
30 East Campus Mall, Madison, WI 53715-1227
Phone (608) 265-5000 · **Fax** (608) 262-6767;
The Chemical Safety Office