Guidelines for the Safe Use of Liquid Nitrogen

I. Purpose:
The purpose of these guidelines is to provide information for the safe handling of liquid nitrogen. The VA Pittsburgh Healthcare System (VAPHS) has several locations in the Research and Development Department where tanks of liquid nitrogen are stored and used.

II. Introduction:
Liquid nitrogen is nitrogen in a liquid state at a very low temperature. It is a cryogenic fluid that causes rapid freezing on contact with living tissue. Since the liquid to gas expansion ratio of nitrogen is 1:694 at 20 degrees Celsius, a tremendous amount of force can be generated if liquid nitrogen is rapidly vaporized. In addition, because of its extremely low temperature, careless handling of liquid nitrogen may result in cold burns. As liquid nitrogen evaporates, it reduces the oxygen concentration in the air and can act like an asphyxiant. Since nitrogen is odorless, colorless and tasteless, it can produce asphyxia without any sensation or prior warning.

Several of the VAPHS research laboratories utilize liquid nitrogen for cryopreservation of biological samples or for storage of cell lines. Due to its multiple hazards and the lack of good warning properties, the following SOP must be followed when handling liquid nitrogen in the laboratory.

III. Potential Hazards

1. **Fire**: The use of liquid nitrogen will condense oxygen from the atmosphere. Exposure of combustible materials to oxygen-enriched liquid nitrogen enhances the combustibility of the material.

2. **Explosion**: A cryogenic liquid such as nitrogen expands by orders of magnitude upon vaporization. One liter of liquid nitrogen becomes 24.6 cubic feet of nitrogen gas. This can cause an explosion of a sealed container.

3. **Asphyxiation**: A poorly or non-ventilated room will be quickly enveloped by the expanding gas of a cryogenic liquid. This will lead to displacement of oxygen and asphyxiation of the user.

IV. Exposure Hazards

**Contact/Absorption**
Cryogenic liquids such as nitrogen are extremely cold at atmosphere pressure. Direct contact with the skin may lead to burns and/or severe frost bite.

**Inhalation**
Inhalation of liquid nitrogen may cause respiratory tract discomfort or irritability. Prolonged exposure may lead to asphyxiation/suffocation.
V. Personal Protective Equipment

Eye Protection
- Safety glasses/goggles and face shields should be worn during operations where liquid nitrogen is being poured from a large container to a Dewar or another smaller container.

Hand Protection
- Loose fitting thermal insulated (cryogloves) or leather gloves are recommended. Check glove manufacturer for recommendations on a suitable glove.

Body Protection
- Long sleeve shirt, lab coat, pants without cuffs and closed toed shoes.
- An impervious full length apron should be worn when transferring liquid nitrogen.

VI. Engineering Controls
Adequate ventilation is essential when working with liquid nitrogen because a small amount of liquid can rapidly convert to a large volume of gas. Do not use in confined spaces because of the threat of asphyxiation.

VII. Special Handling Procedures
- Never allow any unprotected part of the body to touch exposed pipes/vessels containing cryogenic liquids; skin coming in contact with cold metal may adhere to it and tear when attempting to withdraw.
- Exercise caution when adding a cryogenic liquid to a Dewar flask at room temperature to a cryogenic liquid. Both will cause the liquid to boil and splash vigorously.
- Only use containers or equipment specified for cryogenic use.
- Never plug containers holding cryogenic liquid; cover them when not in use to prevent an accumulation of moisture and ice.
- Inspect pressure relief valves on equipment (e.g., 150 Liter Dewar flask) for ice build-up.

VIII. Storage Requirements
1. Store liquid nitrogen containers in a dry ventilated area.
2. Do not store in a confined space area.
3. Never place liquid nitrogen in a sealed container or object that could cause entrapment of the gas.

IX. Labeling Requirements
Identify containers with the name of the cryogenic liquid (e.g., liquid nitrogen). Label storage areas appropriately as well.

X. First Aid
Recovery from frostbite may be complete if only the skin and underlying tissues are damaged. If blood vessels are damaged, gangrene may ensue which may require amputation of the affected area. Contact Occupational Health (412-360-3556) and request medical assistance.
If medical assistance is not immediately available, re-warming first aid may be given:
1. Immerse the affected area(s) in warm (never HOT) water, or apply warm cloths repeatedly for 20 to 30 minutes. The recommended water temperature is 104 to 108 degrees Fahrenheit. Keep circulating the water to aid the warming process. Severe burning pain, swelling and color change may occur during the warming process. Warming is complete when the skin is soft and sensation returns.
2. Apply dry, sterile dressing to frostbitten areas. Put dressings between frostbitten fingers or toes to keep them separated.
3. Move thawed areas as little as possible.

XI. Transport of Liquid Nitrogen
The following procedure will be followed for the delivery and storage of the liquid nitrogen:
1. The vendor will go to the designated storage/use area.
2. The vendor will transport the empty tank to the nearest freight elevator.
3. The empty tank will then be transported to the loading dock area where it will be exchanged for a full one.
4. The full tank will be transported to the freight elevator and back to the designated storage/use area.

XII. Spill and Accident Procedure
During the transport of the tank, if there is an emergency spill or leak which would generate a potential oxygen deficient atmosphere, the tank will be immediately taken to the outside loading dock area. It will be the vendor’s responsibility to eliminate the emergency situation.

Each location where liquid nitrogen is stored will have an oxygen detector in place. The oxygen detectors should display 20.8% oxygen in a well-ventilated area. The Occupational Safety and Health Administration (OSHA) specifies that a hazardous atmosphere may include one where the oxygen concentration is below 19.5% and above 23.5%. The oxygen detector will alarm when the amount of oxygen in the atmosphere goes below 19.5% (due to displacement by the nitrogen).

For a small spill in a well ventilated area when the oxygen detector does not go into alarm state, the spill can be cleaned up using universal absorbent pads. Use appropriate personal protective equipment when cleaning up. Once clean-up is complete, contact the Safety Office/Spill Team Coordinator at 412-360-3705 (cell phone 412-216-2342) for notification purposes.

For a spill or leak in the storage/use area and the detector goes into alarm state (less than 19.5% oxygen), do the following:
1. Notify others in the immediate and surrounding area.
2. Evaluate the spill area and evacuate; assemble outside of the lab area.
3. Prevent others from entering the area.
4. Immediately contact the Safety Office/Spill Team Coordinator at 412-360-3705 (cell phone 412-216-2342).
5. The Spill Team Coordinator will make a determination and may contact the VA Police at 911.
6. If necessary, the VA Police will then summon the City of Pittsburgh Police Department to notify the local Hazmat Team of the emergency incident.