Liquid Nitrogen Handling and Use

Overview

Liquid nitrogen (LN_2) is inert, colorless, odorless, non-corrosive, non-flammable, tasteless, extremely cold, and has no warning properties. It poses a risk of explosion if stored in unvented containers and asphyxiation if not used in well-ventilated areas. Special care must be taken by personnel who handle or work in areas where liquid nitrogen is used. Additionally, the New York City Fire Department (FDNY) has specific requirements and restrictions for the safe storage, handling, and use of liquid nitrogen.

Applicability

This Update includes information from the updated New York City Fire Code, which implemented new regulations regarding the storage and use of cryogenic liquids (including LN_2). All labs that store or use liquid nitrogen must comply with the Handling and Storage requirements listed in this Update. In addition, this Update provides general hazard warning and safety precaution information to users of LN_2. Laboratory personnel who work with or in areas where LN_2 is used must know and understand these guidelines.

Responsibilities

Personnel working with LN_2 must follow this Update and contact EHS for assistance and training as needed. Formerly the G-97, the G-79 Certificate of Fitness (CoF) for the "Supervision of Storage, Handling and Use of Commercial Cryogenic Systems" applies to cryogenic liquids NOT stored or used in an FDNY-permitted laboratory. If cryogenic liquids are stored or used in an FDNY-permitted laboratory, only the C-14 "Supervising Non-Production Chemical Laboratories" CoF is required.

Environmental Health and Safety (EHS) provides assistance and training on the safe storage, handling, and use of LN_2 upon request and assists personnel applying for the C-14 or G-79 CoF.

Health Hazards

- Humans cannot reliably detect the presence of nitrogen.
- Asphyxiation may result from oxygen displacement in the air with nitrogen to levels with insufficient oxygen to support life. Inhalation of oxygen-deficient air can cause dizziness, nausea, vomiting, loss of consciousness, and death.
- Liquid nitrogen has a 700x expansion ratio which may create physical hazards and injuries from the explosion of unvented containers (e.g., cryovials), equipment, or other devices.
- Extensive tissue damage or burns can result from exposure to LN_2 or cold nitrogen vapors.

First Aid

Personnel who have been exposed to LN_2 must seek immediate medical assistance from Workforce Health and Safety (WHS), Student Health Services (SHS), or the Emergency Department (ED), depending on the severity of the exposure.

Frostbite Exposure: In the event of frostbite from skin contact with LN_2, follow the procedures below:

- Remove any clothing that may restrict circulation to the frozen area.
- Do not rub frozen parts, as tissue damage may result.
- Place the affected area in a warm-water bath with a temperature that does not exceed 105°F (40°C). Never use dry heat.
- Seek medical attention from Workforce Health & Safety, Student Health Services, or the New York-Presbyterian Emergency Department.

Personal Protective Equipment

In addition to proper lab attire (e.g., covered legs, closed-toe shoes, etc.), the following personal protective equipment is required when handling or using LN_2:

- Lab coat.
- Safety goggles and/or face shields (Figure 1).
- Waterproof thermal insulated gloves (e.g., cryo gloves, as shown in Figure 2).

Figure 1. Goggles (North Safety Products at VWR)

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Hands must be protected with waterproof thermal insulated gloves that can be quickly removed if LN_2 is spilled on them. Insulated gloves are not intended for submersing hands into LN_2.

Eyes are most sensitive to the extreme cold of LN_2 and its vapors. Over-pressurization may result in the explosion of improperly vented equipment. Chemical splash goggles must be utilized when handling LN_2 and when handling sealed containers that have been stored in LN_2 (e.g., cryovials). Face shields offer additional protection.

Body must be protected with pants, lab coat, and closed-toe shoes. Thermal insulated aprons are available from suppliers like Tempshield and would offer additional body protection.

Figure 2. Gloves (Tempshield, Inc. at VWR)

Handling and Storage

- The storage and dispensing of LN_2 in public corridors are strictly prohibited. Contact EHS for clarification on corridor designations.
- LN_2 containers/tanks must be kept at least three (3) feet from all room or area exits and ten (10) feet from building exits.
- **Store and use LN_2 only in well-ventilated areas**. Do not store in confined spaces or non-ventilated areas (e.g., cold rooms or closets).
- **Store containers in an upright position**. Do not drop, tip, or roll containers on their sides.
- **Use only approved containers** with lids to store and transport LN_2 (e.g., Thermolyne Thermo-Flask®). Lids must be vented to allow the off-gassing of over-pressurized nitrogen gas.
- **Never vapor-seal** LN_2 storage containers.
- **Never plug, remove, or tamper with any pressure relief device.** Under normal conditions, these containers are designed to vent gas periodically.
- **The FDNY requires** the installation of an oxygen monitor in labs where greater than 60 gallons of liquid nitrogen is stored/dispensed. Contact EHS to assess if an oxygen monitor is required and to obtain an oxygen monitor.

Figure 3. Thermo-Flask ® containers pictured are manufactured by Fisher Scientific.

- **Storage Limits.** For liquid nitrogen and other cryogenic liquids, the FDNY allows each permitted lab space to store a maximum of 20,000 scf (approximately 920 liters). Storage and handling of liquid nitrogen in excess of 20,000 scf but less than 40,000 scf requires additional precautions be met and on file with the FDNY Laboratory Inspection Unit. Contact EHS if you will need to store between 20,000-40,000 scf of any cryogenic liquid.

Sample Storage Precautions

WARNING - Do not store cryovials in the liquid phase of LN_2 unless specifically approved by the manufacturer for liquid phase storage. Liquid can still enter closed screw-top cryovials with o-rings and explode when removed from storage.

Laboratory personnel must use **extreme caution** when preserving samples in LN_2. LN_2 storage consists of a **liquid phase** and a **gaseous phase,** as illustrated in Figure 4. If cryovials are immersed in the liquid phase, LN_2 can still enter the closed screw-top cryovials with o-rings during storage. The cryovial may then explode when removed from storage due to the vaporization and expansion (700x expansion ratio) of the liquid nitrogen inside the cryovial.

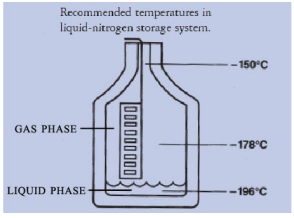

Figure 4. Image courtesy of Nalge Nunc International

Safety Precautions:

- Use only manufacturer-approved containers (e.g., cryovials) for storage in LN_2.
- If storage in the LN_2 liquid phase is required, utilize either:
  - Manufacturer-approved cryovials specifically designed for liquid phase storage; or
  - Gaseous phase-approved screw-top cryovials that are then hermetically sealed in an outer protective envelope designed for use in LN_2. Nalge Nunc International manufactures CryoFlex™ tubing specifically for hermetically sealing cryovials for liquid phase storage.
- Where feasible, the risk of explosion of cryovials stored in the LN_2 liquid phase can be further reduced by moving cryovials to the gaseous phase in the LN_2 container for at least 24 hours before moving to room temperature.
- Where feasible, the handling of containers (e.g., cryovials) inside of Biological Safety Cabinets or Chemical Hoods (with the sash lowered) will further reduce the risk of injury from explosions caused by excess pressure within containers.

Certificate of Fitness

The storage, handling, and use of 60 or more gallons (the sum of tanks and dewars) **in non-FDNY laboratory permitted spaces** must be under the direct supervision of a G-79 CoF holder.

If cryogenic liquids are stored or used **in an FDNY-permitted laboratory**, only a C-14 CoF is required. EHS is available to assist qualifying personnel in obtaining a C-14 CoF through an Alternate Issuance Application program. More information, including the list of qualifications, is listed on the EHS website and the C-14 Application Overview & Checklist.

EHS is available to assist personnel in obtaining the G-79 CoF by providing training on campus and by submitting the associated applications and documentation to the FDNY. Please contact EHS to arrange a group training session. Personnel may also apply directly to the FDNY. For information about how to apply, visit the FDNY CoF website at: https://www1.nyc.gov/site/fdny/business/all-certifications/certificates-of-fitness.page.

Figure 5 Example DOT-4L 180 Liter LN_2 Tank.

References

- **EHS** C-14 Application Overview & Checklist
- **Air Products and Chemicals, Inc**., "Safetygram-7: Liquid Nitrogen"
- **Nalge Nunc International,** "Nunc Cryopreservation Manual"
- **Personal Protective Equipment** Tempshield, Inc.
- New York City Fire Code
- FDNY G-79 Certificate of Fitness