GUIDELINES FOR LIQUID NITROGEN STORAGE, USE & TRANSPORTATION

1.0 INTRODUCTION

CMU UTM is committed to comply with the rules and regulations enforced by the authorities. Other than procurement process of hazardous substances, liquid nitrogen – storage, use and transportation is the most important matters to obey the regulations. All UTM staff and students should adhere to the compulsory requirement before handling liquid nitrogen.

2.0 PURPOSE

This guidance is intended to provide information on the hazards and risks associated with the use of liquid nitrogen and the control measures which can be used. The contents of this guidance should be brought to the attention of all users of liquid nitrogen. In many cases additional local information will be required to cover the circumstances in which liquid nitrogen is being used within laboratories. This information should be supplemented by appropriate training and demonstration where specific tasks are undertaken.

3.0 RESPONSIBILITY AND ACCOUNTABILITY

Storage area owner is responsible to display the safety signage as a form of communication to other people to prevent from any accident/ incident that may occur. All parties involved in the chemical supply, acceptance and/or use of the goods including staff, students and other external parties, are responsible in ensuring the instructions of handling of chemical or gas are followed according to the signage displayed at the storage area.

4.0 REQUIREMENT

4.1 Risk Assessment

It is particularly important that a risk assessment is completed for areas storing quantities of liquid nitrogen that present a significant risk of asphyxiation. For example, in the event of spillage or the release of cylinder contents in the event of a valve failure. The process for completing a risk assessment for the handling and use of liquid nitrogen follows the same general rules for HIRARC:

- HI – Hazard Identification
- RA – Risk Assessment
- RC – Risk Control

The remaining sections below will help you to identify the hazards and determine the relevant control measures needed.

4.2 Properties and Hazards

4.2.1 General Properties

Liquid nitrogen is a colorless, odorless liquid with a boiling point of -196^{0}C. At low temperatures the gas / vapor is heavier than air. Small amounts of liquid vaporize rapidly to produce large volumes of gas (1 liter of liquid nitrogen will produce 0.7m^3 of gas). Nitrogen gas is invisible - the cloudy vapor which appears when liquid nitrogen is exposed to air is condensed moisture, not the gas itself.

4.2.2 Asphyxiation

One of the main dangers associated with liquid nitrogen is the risk of asphyxiation when used or stored in poorly ventilated areas. Liquid nitrogen evolves into nitrogen gas which is inert and non-toxic but there is a risk of asphyxiation in situations where high concentrations may accumulate and subsequently displace air from the room.

Short exposures to cold gas vapor led to discomfort in breathing whilst prolonged inhalation can produce serious effects on the lungs and could possibly provoke an asthma attack.

4.2.3 Cryogenic burns

Liquid nitrogen can cause cryogenic burns if the substance itself, or surfaces which are or have been in contact with the substance (e.g. metal transfer hoses), come into contact with the skin. Local pain may be felt as the skin cools, though intense pain can occur when cold burns thaw and, if the area affected is large enough, the person may go into shock.

4.2.4 Frostbite

Continued exposure of unprotected flesh to cold atmospheres can result in frostbite. There is usually sufficient warning by local pain whilst the freezing action is taking place.

4.2.5 Hypothermia

Low air temperatures arising from the proximity of liquefied gases can cause hypothermia. Susceptibility is dependent upon temperature, exposure time and the individual concerned (older people are more likely to succumb).

4.3 First Aid

Where inhalation has occurred, the victim (who may be unconscious) should be removed to a well-ventilated area. Rescuers should not put themselves at risk - a contaminated area should not be entered unless considered safe. Breathing apparatus may be required but should only be used by trained personnel. The person should be kept warm and rested whilst medical attention is obtained. If breathing has stopped then resuscitation should be commenced by a trained first aider.

Where contact has occurred, the aim should be to slowly raise the temperature of the affected area back to normal. For minor injuries, clothing should be loosened, and the person made comfortable. Clothing should not be pulled away from burned or frozen skin. The affected area should be doused with copious quantities of tepid water (40^{o}C) for at least 15 minutes, and a sterile burn dressing applied to protect the injury until the person can be taken to receive hospital treatment. Do not:

- use a direct source of heat such as a radiator
- permit smoking or alcohol consumption
- give analgesics (e.g. Paracetamol, aspirin)

4.4 Personal Protective Equipment (PPE)

Picture 1: Example of Full Cryogenic PPE

4.4.1 Hands

Non-absorbent insulated gloves must always be worn when handling anything that is or has been in recent contact with liquid nitrogen. Cryogenic gloves are designed to be used in the vapour phase only and should not be immersed into liquid nitrogen under any circumstances. They should be a loose fit to facilitate easy removal. Gauntlet style gloves are not recommended for some liquid handling uses as liquid can drip into them and become trapped against the skin - sleeves should cover the ends of gloves or alternatively, a ribbed cuff style may be used.

4.4.2 Face

A full-face visor should be used to protect the eyes and face where splashing or spraying may occur and where operations are carried out at eye level e.g., when topping up reservoirs on electron microscopes.

4.4.3 Body

A laboratory coat or overalls should be worn at all times. Non-absorbent cryogenic aprons are also commercially available. Open pockets and turn-ups where liquid could collect should be avoided. Trouser bottoms should overlap boots or shoes for the same reason.

4.4.4 Feet

Safety shoes with a re-enforced toecap are recommended for handling liquid nitrogen vessels. Open toed shoes should not be worn under any circumstances.

When not in use, all PPE should be stored in an appropriate manner (e.g. visors on wall mounted hooks) to ensure that it does not become damaged or contaminated.

5.0 PROCEDURE

5.1 General Safe Handling Practices and Storage Requirements

- Only trained personnel should work with liquid nitrogen.
- Use only in well-ventilated and low traffic areas.
- Always wear the appropriate PPE.
- Liquid nitrogen should only be stored in approved containers.
- Do not used a damage container.
- All liquid nitrogen containers must be labelled.
- Gas signage should be posted in the area warning others that liquid nitrogen is being stored and used.
- Avoid breathing liquid nitrogen vapours.
- Carry containers away from body and face.
- Never drop a liquid nitrogen container. Damage to a container may result in over-pressurization or container failure.
- Dewars more than 20L require two people to move safely.
- Always use a specially designed cylinder cart/ trolley to transport liquid nitrogen containers that are too heavy to be hand carried.
- Do not leave open containers unattended.
- Liquid nitrogen containers should be stored in cool, dry, and well-ventilated areas.
- Do not store in a cold room or other controlled environment without air supply.
- Liquid nitrogen containers should be stored out of direct sunlight.

5.2 Transportation of Vessels within the Department

If vessels must be maneuvered between locations and there is a risk or possible risk of injury, then an assessment must be carried out. Before moving transportable containers, the route should be assessed to consider:

- rest stops
- movement through populated work areas
- possible obstructions and clutter
- lifts (see below)
- floor surfaces (are they sound and even?)
- kerbs
- stairs (hazardous due to potential for slips and trips which could result in spillages from small handheld dewars)
- whether the destination for the gas is ready to accept it

Only purpose designed handling equipment should be used. All transportable Dewar vessels are fitted with wheel and/or undercarriages. A two wheeled handling trolley is available for transporting the 20 – 30 litre un- pressurised storage containers and must be used for transporting these containers.

Picture 2: Example of mechanical support for transporting Liquid Nitrogen container.

Transport in lifts

'Vessels should only be transported in lifts when covered by a safe system of work which takes account of the hazards, including that due to oxygen deficiency when a lift is stopped for a period between floors.'

Transportable Vacuum Insulated Containers of not more than 1000 Litres Volume - BCGA Code of Practice CP27

In practice, this means that pressurised vessels (and Dewars) should not be accompanied in lifts. If a goods lift, or passenger lift is used then it should be closed to all passengers. The vessel should be maneuvered into the lift and the lift sent to the destination floor to be met by an assistant.

5.3 Emergency Procedures

In the event of a large spillage or accidental release, the following procedures should be followed:

- Evacuate the area. Deploy warning signs if necessary.
- Ventilate the area. Open doors and windows or activate forced ventilation to allow any spilt liquid to evaporate and the resultant gas to disperse.
- Try to stop the release, if at all possible, e.g. turn off valves, but only if it is safe to do so - always wear protective clothing.
- Do not re-enter the area unless it is proved safe to do so. The presence of oxygen deficiency monitors will indicate the oxygen levels in the vicinity.
- Prevent liquid nitrogen from entering drains, basements, pits, or any confined space where accumulation may be dangerous.

6.0 REFERENCES

6.1 Occupational Safety and Health (Use and Standard of Exposure Chemical Hazardous to Health) Regulations 2000 (USECHH Regulations).
6.2 Occupational Safety and Health (Classification, Labelling and Safety Data Sheet of Hazardous Chemicals) Regulations 2013 (CLASS Regulations).
6.3 Occupations Safety and Health Act 1994 (Act 514).
6.4 Factories and Machinery Act 1967 (Act 139).
6.5 Safety Guidelines for Gas Cylinders (Construction, Operation and Maintenance) 2020, DOSH.
6.6 The OSHA Respiratory Protection Standard ("the Standard"; 29 CFR 1910.134).
6.7 Standard Operating Procedure – Liquid Nitrogen – Storage, Use & Transportation Guidance & Code of Practice., The University of Edinburgh, School of Chemistry.

7.0 GENERAL/ AMENDMENT

Issue No.	Review No.	Amendment Details	Effective Date
1	1/2023	New guidelines from revision of Safe Work Procedure- Liquid Nitrogen Storage, Use & Transportation (CMU/SOP/12)	01/12/2023