Electron Microscopy Unit
Research Infrastructure Centre (RIC)

LIQUID NITROGEN SAFETY INSTRUCTIONS & EMERGENCY RESPONSE PLAN

To be read by all users of liquid nitrogen.

Emergency contacts

My departmental health & safety officer

Name: _____

Telephone number: _____

Emergency Services (Fire Brigade and Ambulance)	Phone 111
University Security and Emergency number	+64 3 479 5000

Liquid Nitrogen Generator room and EM unit contacts

Liquid Nitrogen dispensing assistance:

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Contents of this document

A. Introduction

1. Permission to obtain and use liquid nitrogen (LN2).

Those intending to use LN2 must undergo a training session and be familiar with the associated hazards. Training will include the safe handling of LN2 and the appropriate emergency procedures involved.

It is recommended that users of liquid nitrogen undergo refresher training annually.

2. The hazards involved with using liquid nitrogen (LN2).

There are four major hazards associated with the use and handling of LN2.

1. **Asphixia:** Nitrogen gas displaces oxygen causing potentially lethal hypoxia. Each litre of liquid nitrogen expands to 700 litres. A little as 7 litres, if vaporized, can completely displace the air in a passenger lift while even a smaller volume can result in a lethal drop in oxygen level. Therefore, liquid nitrogen should not be introduced to small, unventilated rooms or spaces (including freezers, especially chest freezers). In small rooms the door should be left open while liquid nitrogen is being used as a precaution. Liquid nitrogen must not be 'stored' in a freezer, it does not significantly reduce the boil-off rate from the dewar and can create a lethal, low-oxygen chamber in the freezer that can lead to asphyxiation.

2. **Expansion explosion**: Because of the high expansion ratio between liquid nitrogen and nitrogen gas, liquid nitrogen must never be put in sealed containers. The pressure in a sealed container can quickly build to the point where the vessel explodes. Without exception, all containers must have a loose-fitting top, a vent hole or a pressure release valve. This allows the gas to escape as it boils off. This applies to all storage and transfer dewars and specimen containers such as cryovials. NB: Normal cryovials can be made safe for submerging in liquid nitrogen by making a small hole in the lid, otherwise they should not be submerged in liquid nitrogen.

3. **Freezing of tissue**: Contact with skin or eyes can result in serious injury. LN2 is extremely cold (-196^{o}C). LN2 and the cold gas stream that comes from the liquid can rapidly produce frost-burn. Eyes are particularly vulnerable and permanent eye damage can result from contact with LN2.

4. **Asthma**: The inhalation of chilled air may trigger an asthma attack in susceptible individuals.

3. Personal safety equipment.

Suitable protective clothing must be worn at all times when handling LN2 and cold nitrogen gas. Protective clothing includes:

1. **Eye protection**. A full-face visor is best however a goggle with side protection is acceptable.

2. **Insulated, gauntlet-type glove***s*. Handling cold dewar valves should be done only when wearing insulating gloves. Gloves must be loose fitting so they can be removed rapidly if liquid nitrogen accidental spills inside them.

3. **Suitable footwea**r. Wear shoes that cover and protect the feet. Open shoes i.e. sandals and jandals, are not acceptable.

4. **A laboratory coat**. A coat without front pockets is preferable.

4. Working with liquid nitrogen (LN2).

Before working with LN2 always have an escape route in case the dewar you are using is accidentally knocked over. Ensure that those working around you are also aware of the risks.

There is a danger of rapid oxygen depletion leading to asphyxiation when working with LN2. It is strongly advised that you never work alone with it. A second person should always be in the immediate work area and this person must also be aware of the dangers. The handling, use and storage of LN2 must only be carried out in a well-ventilated area.

Care must be taken during the transfer of LN2. Always allow the receiving vessel to cool down slowly to LN2 temperature. Boiling often occurs when LN2 is introduced into a wide mouth flask at room temperature. If not careful this boiling may result in LN2 overflowing from the container and causing frost burns. When introducing LN2 into any narrow neck container at room temperature, 'blow-back' from the dewar neck may occur. This results from the rapid vapourisation and expansion of N2 gas inside the dewar.

LN2 dewars should always be covered to prevent the liquification of oxygen - this can cause a layer of liquid oxygen on the liquid nitrogen and pose a fire or explosion hazard. Covered dewars with unwanted liquid nitrogen can be allowed to boil off in a fume hood. Always ensure that your dewar is dry before refilling with liquid nitrogen.

5. Transport of liquid nitrogen (LN2).

The dewar used to transport liquid nitrogen, whether 1 litre or 30 litres, must appropriate for the task. Dewars should be regularly inspected for damage. Condensation on the outside of the dewar (except when filling) is a sign that the dewar insulation has failed. Stop using any such dewar immediately.

The transportation of LN2 through publicly accessible areas, particularly areas where groups (i.e. of students) are moving requires special care.

LN2 should not be transported in a lift unless it is possible to prevent anyone from getting into the lift while it is carrying LN2. There is a risk of asphyxiation if the lift becomes stuck and the dewar boil-off rate is higher than expected, or the dewar is knocked over. If transport in a lift is required between two floors then it is recommended that two people are involved. One person

loads the lift and sets it off, the other waits at the end point to receive the LN2 dewar. If the lift is travelling between several floors and cannot be locked, then there is a risk that people may get in at intermediate floors. In this case someone should also monitor each of the floors in between. Additionally, a sign should be placed in the lift requesting that no one enter.

The manual handling of large liquid nitrogen containers (more than 20 litres in size) requires two people. This is to prevent lifting injuries and to provide help in the case of an accident. Each person must wear suitable safety equipment including insulated gloves and full-face visor.

Wide-neck dewars (storage dewars) should be periodically purged to prevent oxygen build up inside.

B. Protocols in the Event of Spillage

a. Minor spill (less than 500mls)

1. Liquid nitrogen must only be used in a well-ventilated area so any minor spills may normally be allowed to simply evaporate. Ensure good ventilation while evaporation is occurring (open doors and windows if possible).

2. Move all personnel away from the direct area of spillage to prevent any chance contact with liquid nitrogen.

3. Ensure no one enters the area until all liquid has evaporated and sufficient time has elapsed for gaseous nitrogen to be removed.

4. Inform your health and safety officer of the incident.

b. Major spill (more than 500mls)

Major spills are likely to result from either from a spillage from a hand carried transport dewar or from a larger dewar tipping over. Treatment of a major spillage is dependent on the location of the spillage whether inside or outside the building.

Interior spillage

Any large internal LN2 spillage must be treated very seriously and action taken immediately. Because of the rapid conversion of LN2 into a large volume of gaseous nitrogen (a 700-fold expansion) a small, enclosed area will be affected very rapidly be depleted of oxygen, potentially leading to asphyxiation and death.

1. All personnel must be **immediately evacuated** from the surrounding area.

2. Ensure that the area is secured off so no one can enter the spill area from any direction. The security cordon must be sufficiently distant from the spill area to ensure safety of the personnel on duty.

   Consideration must be made for rooms above and below the spill area as well.

3. Contact your departmental spill team. Upon arrival the spill team will manage the response. See attached Appendix, Chemical Spills.

External spillage

1. **Immediately evacuate the spillage area and cordon it off at a safe distance**.

2. Ensure no one enters the spill area. The security cordon must be sufficiently distant from the spill area to ensure safety of the personnel on duty. Be aware of wind direction. Do not stand downwind of the spill.

3. Contact your departmental spill team.

C. First Aid

a. Skin contact – the treatment of cold burns and frost bite

- Remove any clothing that may be holding cryogenic liquid. Loosen any clothing that may restrict blood circulation.

- Do not apply direct heat to the affected parts. If possible, place the affected part in tepid water (do not exceed 40^{o}C), or flush with copious amounts of tepid water.

- Do not rub the affected area in an attempt to improve circulation as tissue damage may result.

- Keep the victim warm as shock may set in. Do not leave the victim alone.

- Send for immediate hospital attention for all but superficial frostbite injuries.

- Protect the frozen parts from further injury or from infection. Dry, sterile dressings can be used for the purpose but they should not be allowed to restrict blood circulation.

b. Eye contact

- Flush with warm water (do not exceed 40^{o}C) for about 15 minutes *then seek immediate hospital attention.* Keep the victim warm.

c. Treatment of asphyxiation

Do not attempt to rescue anyone from a confined space if they were working with liquid nitrogen and have lost consciousness - first raise the alarm, open the door and maximise ventilation to the room. Call the fire brigade (1-111).

It is important to realise that the victim of asphyxiation may not be aware that they are being asphyxiated. If any of the following symptoms appear to affect a workmate in situations where liquid nitrogen is being used, the person needs to be moved to open air as quickly as possible**:**

- Rapid breathing
- Rapid fatigue

- Nausea
- Vomiting
- Inability to move
- Convulsive movements
- Collapse
- Faulty judgment
- Insensitivity to pain
- Abnormal emotions
- Abnormal pulse

- Before taking action quickly assess the level of danger in the area to yourself.
    - **If there is no risk** of asphyxiation or burns to you then immediately move the affected person to the open air.
    - **If there is a risk** of asphyxiation or burns to you then call emergency services immediately (1-111). The Fire Brigade has the breathing equipment required to attempt a rescue.
- If you are able to remove the victim from the area, keep them warm. Shock may set in. Obtain medical help as soon as possible.
- If the victim has become unconscious, if safe to do so, check for a pulse and breathing. If you cannot detect these, administer artificial respiration and ask someone to call an ambulance (1-111). Ask that person to inform you as soon as they have called the ambulance.
- Ask that person to call your departmental spill response team.
- If it can be done safely, shut off the source of the liquid nitrogen and ensure adequate ventilation to dissipate the gas.