

This Information Sheet provides guidance on eliminating or reducing the risks associated with the use of liquid nitrogen, and is aimed at anyone who purchases, transports or uses it.

General Information



Liquid nitrogen is an inert, colourless and odourless liquid, similar in appearance to water and which because of its coldness and ability to rapidly cool and freeze items, is widely used as a coolant in laboratories.

It has a boiling point of -196°C , a freezing point of -210°C and 1 litre can produce 0.7m^3 of gas.

Such inert, extremely cold liquefied gases are often termed *cryogenics*.

General Hazards

Although liquid nitrogen is inert, hazards can arise because of its extremely low temperature:

| Hazard | Issue |
|---------------------|---|
| Low temperature | <ul style="list-style-type: none"> • Can cause severe skin burns or frostbite • Skin can freeze and stick to the liquid causing tearing on removal • Soft materials become brittle and may shatter unexpectedly • Liquid oxygen may condense in containers of liquid nitrogen or vessels cooled by liquid nitrogen • Thermal stress may be caused by rapid temperature changes |
| Vapour | <ul style="list-style-type: none"> • Liquid nitrogen can create nitrogen gas which displaces oxygen leading to asphyxiation • Oxygen condensed into leaking containers can explode on heating following resealing or blockage with ice • Low vapour temperature can cause tissue damage |
| Damage to equipment | <ul style="list-style-type: none"> • Condensation / freezing / ice formation caused by low temperatures around electrical cables may cause damage leading to electric shock • Liquid nitrogen transfer tubes may suddenly crack • Liquid nitrogen should never be poured down sinks as it cracks pipes |



Caused by sleeve not being outside glove



Explosion - caused by boiling liquid nitrogen

Storing and Transporting Liquid Nitrogen (see Safe Use)

Liquid nitrogen must be stored and transported in a vacuum insulated container called a dewar. There are two types. The first used for storage and transport has a narrow neck to aid pouring. The second used for cooling items - it is wider necked and may have removable racking.



Storing / transporting dewar



Cradle - allows dewar to be tipped





Used to cool items - wider neck

Dewars must be suitable for liquid nitrogen, and if built after 1st July 2001, are subject to:


- The Carriage of Dangerous Goods (Classification, Packaging and Labelling) Regulations.
- Use of Transportable Pressure Receptacles Regulations.

Labelling Dewars

Must meet the requirements of the above Regulations as a minimum and include:

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| <ol style="list-style-type: none"> 1. Basic Safety Information 2. Transport Labelling Information incl. <ul style="list-style-type: none"> ○ Product Designation ie Nitrogen Refrigerated Liquid ○ Product UN Number ie UN1977 ○ Product Danger Symbol ie green diamond with a cylinder symbol and '2' 3. Gas Supplier Contacts 4. Unique Insurance ID | <p>Examples:</p> <div style="display: flex; justify-content: space-around; align-items: center;">   </div> <p>Danger signs should have a side length of at least 100mm unless impractical</p> |
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SAFE USE OF LIQUID NITROGEN

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| General – any person handling liquid nitrogen must: | 1. Be trained and competent 2. Wear PPE as follows: | |
| | Eyes: | Goggles, face visor eg BS EN 166 Grade 3 |
| | Hands: | Non-absorbent, insulated gloves with sleeves covering the end of the glove eg BS EN 511 |
| | Feet: | Enclosed shoes, preferably with reinforced toe caps. Trousers should be worn outside the shoe |
| | Body: | Overalls or lab coat, without pockets where liquid could collect |
| Handling Dewars | <ul style="list-style-type: none"> • Carry out a Manual Handling Assessment – use trolleys / cradles • Beware of items that could trap liquid close to the skin eg rings, bracelets • Keep dewar upright unless pouring from a specifically designed dewar • Never ‘walk’, roll or drag a dewar • Avoid jolting / impacts against the dewar • Use tongs to remove objects, handle both carefully • Only use in well ventilated areas | |
| Removing Liquid Nitrogen from Dewar | <ul style="list-style-type: none"> • Always use a liquid withdrawal device fitted with a pressure relief device that stops the internal pressure exceeding the dewar’s design limit • Use with a clamping device to restrain travel in case of pump failure |  |
| Filling Liquid Nitrogen Dewar – only carry out during normal working hours | <p>PRE-FILL - CHECK</p> <ul style="list-style-type: none"> • The dewar is suitable for liquid nitrogen and is in a well-ventilated area • Operating pressure is correct (only competent persons can vent tanks) • The filling equipment is clean and free from damage • Liquid withdrawal devices have been removed • There is no water / ice on the inside or excessive frosting around the neck <p>FILLING</p> <ul style="list-style-type: none"> • Purge the hose to clear excess atmospheric moisture / dust • Insert the fill hose into the dewar, check it is secure • Start the fill by cracking open the fill valve • Once the dewar is cooled, open the valve to set up a steady flow • For dewars with no neck tubes stop filling when the liquid reaches a level below where the insulating bung will reach when replaced • When full replace the protective cap – rattling means it is overfilled • Fit withdrawal devices straight after fill. Ensure dewar is not overfilled • Replace any damaged labelling | |

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| <p>Moving Liquid Nitrogen Dewars</p> | <p>GENERAL</p> <ul style="list-style-type: none"> • Never walk, roll or drag a dewar • Avoid jolting / impacts against the dewar <p>MOVING DEWARS UP STAIRS</p> <ul style="list-style-type: none"> • If the use of stairs is unavoidable, restrict access to the stairs eg display 'No Entry' signs top and bottom and use two people to move the dewar <p>MOVING IN A LIFT</p> <p>If the use of a lift is unavoidable adopt the following:</p> <ul style="list-style-type: none"> • Check the lift has an emergency alarm / telephone • Only fill the dewar to 90% capacity • Vent liquid withdrawal devices to less than half relief-valve pressure • Use two trained / competent persons to move the dewar: <ul style="list-style-type: none"> ○ One to put the dewar in the lift and send to the correct floor (use call override if possible, if unavailable place a 'No Entry' sign around the dewar neck) ○ The second to wait at the floor the dewar is travelling to |
| <p>NEVER:</p> | <ol style="list-style-type: none"> 1. Accompany a dewar in a lift 2. Move a dewar that is venting gas, leaking, damaged etc 3. Move an overfilled dewar 4. Vent dewars in lifts |
| <p>Storing Liquid Nitrogen Dewars</p> | <p>FULL / PART FULL DEWARS</p> <ul style="list-style-type: none"> • Store in a designated, secure area • Ensure the area is well-ventilated, dry and sheltered from rain • Always store with protective caps fitted <p>EMPTY DEWARS</p> <ul style="list-style-type: none"> • Check the dewar is completely empty before storing • Only empty in a secure, well-ventilated area. Allow liquid to evaporate naturally. Never pour down the sink / drain • Ensure the storage area is dry • Always store with the protective cap in place |
| <p>Ventilation</p> | <p>Liquid nitrogen is heavier than air . Take care if using in a room where it could be trapped eg basements, ducting. If possible, store / use in rooms with good natural ventilation. If this is not possible:</p> <ul style="list-style-type: none"> • The room must have forced ventilation of at least 1 air change an hour • The room must have an oxygen deficiency alarm installed in the room • The alarm signal must be audible / visible from outside the room • Alarm malfunctions must be visible / audible from outside the room • The alarm must be checked following manufacturer's guidance |

Calculating Ventilation Requirements

NORMAL OPERATION

Ventilation should be sufficient to ensure oxygen does not fall below 19.5% during the following normal conditions:

- Normal evaporation of all liquid nitrogen containers in the room
- Losses when filling the largest dewar in warm conditions

SPILLAGE

- Total spill of the largest dewar must not cause oxygen to fall below 18%

Effect of Spillage on Oxygen Concentration

| Room volume m3 | Volume of liquid nitrogen spilled, litres | | | | | | |
|----------------|---|------|------|------|------|------|------|
| | 1 | 2 | 3 | 4 | 5 | 10 | 25 |
| 10 | 19.6 | 18.1 | 16.7 | 15.3 | 13.8 | 6.7 | |
| 25 | 20.4 | 19.9 | 19.3 | 18.7 | 18.1 | 15.3 | |
| 50 | 20.7 | 20.4 | 20.1 | 19.9 | 19.6 | 18.1 | |
| 75 | 20.8 | 20.6 | 20.4 | 20.2 | 20.0 | 19.1 | 16.2 |
| 100 | 20.9 | 20.7 | 20.6 | 20.4 | 20.3 | 19.6 | 17.4 |

Resulting % Oxygen Concentration = 100 x Vo / Vr

Where:

Vo = the volume of air, m³

Vr = the room volume, m³

Vd = dewar capacity

Fg = gas factor – 683 for nitrogen

0.21 = the normal concentration of oxygen in air

Vo can be calculated as follows:

$$Vo = \frac{0.21 Vr - Vd \times Fg}{1000}$$

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| Transporting Liquid Nitrogen Dewars | <p>REGULATORY REQUIREMENTS</p> <p>Liquid nitrogen dewars moved by road must comply and be labelled in accordance with the Carriage of Dangerous Goods (Classification, Packaging and Labeling) and the use of Transportable Pressure Receptacles Regs.</p> <p>Recipients of dewars must hold a Gas Safety Data Sheet.</p> <p>GENERAL TRANSPORT RECOMMENDATIONS</p> <ul style="list-style-type: none"> • Dewar must be in a separate compartment from the driver / passengers • Drivers must be trained in the use of liquid nitrogen dewars • Always check the dewar for damage etc before transporting • Fit a protective cap. Do not secure unless integral to the cap design • Ensure the dewar is appropriately labelled • Secure the dewar during transport to prevent spill / damage |
| NEVER: | TRANSPORT DEWARs IN CARS |
| General Maintenance | <p>In addition to general checks eg before filling, transporting carry out the following regularly (not exceeding six months):</p> <ul style="list-style-type: none"> • Empty dewar in a well ventilated area • Allow liquid to evaporate naturally • Check the cap and liquid withdrawal device condition, replace if necessary • Check the dewar for damage, the neck for twisting etc • Ensure the dewar is free from dirt and contaminants • If contaminated wash the dewar out with warm water • Check the dewar is completely dry before refilling |

EMERGENCY PROCEDURES

SMALL SPILLS

1. Evacuate all personnel from the area likely to be affected
2. Ventilate the area

LARGE SPILLS

1. Evacuate all personnel from the area likely to be affected
2. Never allow anyone to enter the evolved gas – it could burn
3. Close interior doors to stop gas flowing to vulnerable areas eg ducts, basements
4. Open exterior doors and windows to encourage evaporation of the liquid / dispersal of gas
5. Allow the liquid to evaporate naturally
6. Never allow anyone to enter the area until the nitrogen gas has dispersed. Check with an oxygen monitor if necessary

ICE PLUGS

To deal with ice plugs that can detach at high velocity or cause pressure to build up:

1. Evacuate all personnel from the area except those required to deal with the plug
2. The recommended method to deal with a plug is to insert a copper tube into the neck and blow warm nitrogen gas into the blockage. To do this safely:
 - Sandbag the dewar before approaching it
 - Carefully insert a copper tube into the neck. **DO NOT MAKE CONTACT WITH THE ICE**
 - Set up the gas supply so it can be operated in a remote / protected position
 - Commence the defrost process, move to a safe place until blockage is cleared
 - Ensure dewar is examined by a competent person before returning to service



FIRST AID ACTION

INHALATION

1. Remove person to well-ventilated area. Rescuers may require BA equipment
2. Call University Security on **333/2795** to summon an ambulance
3. Keep the person warm and rested until help arrives

SKIN CONTACT

1. Call University Security on **333/2795** to summon an ambulance
2. Whilst waiting:
 - Loosen any restrictive clothing
 - Place the affected part under tepid water, until the skin changes from pale yellow through blue to pink or red
 - Protect frozen parts with loose, dry, sterile dressing
 - Keep the patient warm and rested

NEVER

1. Pull clothing away from burned / frozen skin
2. Apply a direct heat source eg heater
3. Allow smoking or alcohol consumption
4. Give analgesics eg paracetamol, aspirin