Guidance on the Safe Use and Storage of Liquid Nitrogen
Policy… Code of Practice… Guidance✓Procedure…
Organisation-wide✓Local…
Approved by the University Health & Safety Committee
Chairperson Dr Derek Millard Healy Date Oct 2023 Review date 2026

1 Contents

2 Introduction

Brunel University London (BUL) has a responsibility under Health and Safety legislation to provide and maintain plant and systems of work, which are safe, and without risk to health (Health & Safety at Work etc. Act 1974).

Accidents involving liquid nitrogen can cause serious injury or even death. This guidance provides simple practical advice on eliminating or reducing the risks associated with using liquid nitrogen. Liquid nitrogen is an odourless and colourless gas and exists at -196°C at atmospheric pressure.

Severe damage to the skin and eyes can be caused by liquid nitrogen. Liquid nitrogen if released can expand and displace air so therefore is an asphyxiation risk.

3 Scope

This organisational guidance applies to the Uxbridge campus as a whole.

4 Responsibilities

4.1 Deans and Directors of College Operations, Institutes and/or Professional Services

Deans and Director of College Operations, Institutes and/or Professional Services are responsible for making the following arrangements:

Ensuring compliance with the requirements of this guidance and bringing this Guidance on the Use and Storage of liquid nitrogen to the attention of those within their areas of responsibility who work with or control liquid nitrogen.

4.2 Divisional Managers / Head of Departments

Divisional Managers / Head of Departments and or those that work with or control liquid nitrogen are responsible for:

Ensuring, where applicable, that an inventory is maintained of the volume of liquid nitrogen within the College/Institute and/or Department. The information should be kept up to date and include; vessels both in use and in storage, the location and type of vessel, record the users and projects with which the vessel is associated and ensure that training records must be kept and training must be regularly updated.

- Appointing a responsible person locally to have overall control of liquid nitrogen in their area; co-ordinate the inspection of vessels to ensure there is no leakage of gas.
- Ensuring that both staff and students must be trained in the correct procedures for the use of liquid nitrogen and ensure that all procedures are appropriately supervised.

4.3 Staff and Students (Users)

All users must receive appropriate training prior to working with liquid nitrogen, to ensure that they are competent to use liquid nitrogen. This training should be documented and recorded. They should understand the risks associated with liquid nitrogen4 Arrangements

5 Use of Liquid Nitrogen

A written risk assessment must be prepared wherever liquid nitrogen is used or stored, describing any control measures needed to minimise its dangers. The assessment must consider all relevant risks, including the risk of asphyxiation the risk assessment describes, where necessary, any control measures, any emergency procedures, and who is authorised to carry out various tasks associated with the use of liquid nitrogen.

Only suitably constructed Dewars or transportable liquid cylinders must be used for liquid nitrogen; this equipment must be maintained according to the manufacturer's instructions. All static and transportable pressurised vessels must be maintained and tested in accordance with the Transportable Pressure Vessels Regulations 2001 (SI2001/1426).

The maintenance of storage vessels is a Departmental responsibility and all records of inspections must be kept. Users should report any obvious damage sustained by vessels (either static or transportable) immediately to the Head of Department/Services Manager and if necessary, the vessel should be taken out of use until inspected by a competent person. Regulators should only be replaced by trained staff

5.1 The main hazards are:

- **Asphyxiation** in oxygen deficient atmospheres. Small amounts of liquid vaporize into large volumes of gas – one litre of liquid nitrogen becomes approximately 700 litres (0.7m3) of nitrogen gas. Physical affects can be seen at Oxygen concentrations below 18% - Death is possible below 11%.

- **Combustion Hazard**. Liquid nitrogen can condense air from the atmosphere, which can lead to production of liquid containing higher oxygen content than that of air and consequently a combustion hazard. This can happen if Dewar's and insulated flasks containing liquid nitrogen are left open, allowing oxygen to condense, which gives rise to the risk of explosion or fire on contact with flammable solvents, oil or grease.

  Cold burns, frostbite and hypothermia from the intense cold. The liquid is at -195°C & can therefore freeze human flesh very rapidly. Objects cooled by liquid nitrogen can stick fast to the skin and the flesh may be torn on removal. Eyes are more vulnerable than skin and can be damaged by exposure to the cold gas as well as the liquid.

Transient exposure to very cold gas causes discomfort in breathing and can trigger an asthma attack in susceptible people.

Over pressurisation from the large volume expansion of the liquid. For example, if liquid nitrogen enters sample vials during storage, the vials when removed from the liquid nitrogen can become rapidly over pressurised and explode in the face of the user.

Brittle fracture of materials such as carbon steel.

5.2 The main causes of accidents are:

- Inadequate training and supervision;
- No Risk Assessments
- No Standard Operating Procedures
- No Equipment Inspections
- Poor work practices
- Poor storage;
- Inadequately ventilated working conditions;
- Incorrect filling procedures;
- Hidden damage.

5.3 Training

Anyone who uses a liquid nitrogen should be suitably trained and have the necessary skills to carry out their job safely. They should understand the risks associated with liquid nitrogen.

Recommended Training http://www.gas-safe-interactive.com/university-compressed-cylinders.htm

In particular:

- new employees should receive training and be supervised closely;
- Training in liquid nitrogen safety needs to be refreshed every 3 years. Areas that use liquid nitrogen must identify who needs training and make arrangements;

6 How to Reduce the Risks

6.1 Personal Protective Equipment

Users of liquid nitrogen must always wear appropriate of personal protective equipment so that in so far as is possible they are physically protected from the material. Users should always ensure that they keep liquid nitrogen off their bodies / clothing and out of their lungs and eyes.

The types of personal protective equipment required will depend on the type of usage. The larger the volume of material handled and the greater the potential for body contact then the greater the degree of protection that is required.

6.2 Gloves

Protective gloves should be worn if there is a risk of material spillage onto the hands. Protective gloves must conform to BS EN 511 (Cold Protection). The gloves should be specifically designed for cryogenic handling with ribbed cuffs to prevent splashing into the glove.

The glove material should be rough to give good grip while handling cooled vessels and not increase the chance of spillage. Glove material should be non-porous to prevent liquid nitrogen entering the space between the glove material and the skin.

6.3 Protective Clothing

Standard lab safety clothing is suitable for handling small volumes of liquid nitrogen. This consists of a closed lab coat and if necessary an apron. Legs must be completely covered.

5.4 Eye Protection

When working with small volumes of liquid nitrogen safety glasses with integral side protection should be worn. When handling larger volumes of liquid nitrogen or decanting material consideration should always be given to the wearing of goggles or a face shield.

5.5 Footwear

Feet should be covered when working with liquid nitrogen. The wearing of sandals or open toed shoes or similar must be avoided.

5.6 Reduce the Risk of Asphyxiation

Liquid nitrogen must be used and stored safely so as to minimise the risk asphyxiation. Asphyxiation can occur of nitrogen gas is allowed to reach an unsafe level in the atmosphere. One litre of liquid nitrogen can generate 682 litres of nitrogen gas.

This gas can drive down the relative concentration of oxygen in the atmosphere (especially in confined and poorly vented areas) leading to potential health effects. Storage vessels for liquid nitrogen are designed so that nitrogen gas can boil off. In larger systems this vented nitrogen gas is often collected and piped off safely.

However in most storage vessels the gas vents to atmosphere. This can be a significant safety issue in bulk storage area. When storing and using liquid nitrogen there are a number of rules must be followed to minimise the risk of asphyxiation:

Liquid nitrogen should not be transported through heavily populated areas of buildings in case of spillages. Persons involved in the transport of liquid nitrogen should wear appropriate personal protective equipment.

5.7 Lifts

When using lifts to transport liquid nitrogen the following should be adhered to:

- Dewars must not be accompanied in lift. A lift is a confined space and should leakages occur asphyxiation is possible. One person should place the Dewar in the lift whilst another waits to receive the Dewar from the lift once the journey is complete. People must be prevented for boarding the lift on any floor that the lift passes on route to its destination.

- Storage areas and areas in which liquid nitrogen is in use should be subjected to an assessment of potential oxygen levels during spillages, storage and topping up / refilling activities. If deemed necessary by this exercise the atmospheric oxygen depletion sensors must be installed in the relevant areas or the ventilation must be improved.

7 Storage

Liquid Nitrogen should not be stored for excessive periods of time. Only purchase sufficient quantities of gas to cover short-term needs. Liquid Nitrogen Storage areas where liquid nitrogen is used and stored must have adequate ventilation. Adequate means that oxygen levels are maintained at 20.8% concentration during normal storage and handling.

Gas release can occur during storage of liquid nitrogen from open non-pressurised vessels during routine operations due to the warming of liquid nitrogen vessels. In the case of non-pressurised vessels this occurs naturally through the insulation. In pressurised vessels when the pressure increases the valve opens to relieve the buildup and then resets due to the failure of the pressure relief valve which will rupture the burst disc on pressurised vessels.

This will cause a rapid release of gas in a short space of time. The volume of the storage area in relation to the quantity of gas released will determine the extent to which oxygen will be depleted. You should calculate the oxygen concentration that would result should the full contents of the largest vessel be accidentally released in a short space of time i.e. worst case scenario. An oxygen depletion calculator is provided. To use

it you will need to know the width, height (exclude space over 2.4m) and length of the liquid nitrogen storage area and the volume of liquid nitrogen contained in the vessel. If the resultant O2 concentration is greater than 18% then it may not be necessary to install an O2 depletion monitor, however if it is less than this a monitor is essential.

N.B. An alarm is not an alternative to the provision of a safe system of work but is an additional control measure, which gives an early warning that something has gone wrong, i.e. a spill or rapid release of liquid nitrogen.

8 Oxygen Depletion Monitoring

Where an O_2 depletion monitor is in use it must be re-calibrated, serviced and a replacement battery fitted according to the manufacturer's instructions. The monitor should be fitted near to the liquid nitrogen vessel(s) approximately eighteen inches from the floor.

The monitor alarm should be audible in adjacent areas. A remote sounder can be mounted outside the door to warn of the danger inside. Remote sounders can be purchased with digital readouts indicating actual oxygen concentrations. A log should be kept of all occasions when the alarm sounds. If the monitor alarm sounds frequently during routine operations DO NOT SWITCH IT OFF. Review the system of work and the siting of the monitor.

9 Emergency Procedures

Emergency procedures should be defined and users should be familiar with what to do in an emergency:

9.1 Fire

- Operate the planned fire drill for the area in question. On arrival, emergency services should be informed of the types of gases present in the area affected.
- If possible, isolate any piped supplies to the area affected **but do not take any unnecessary risks**.
- Cylinders may burst, vent or explode when subjected to extreme temperatures so avoid 'first aid' firefighting (e.g. using extinguishers) unless the fire is small and can be dealt with very quickly. Err on the side of safety - if in any doubt, evacuate and leave to the professionals.
- Do not approach any cylinder which has been affected by fire. The emergency services and supplier will deal with matters when safe to do so and the supplier will recover them for disposal.