

Working Safely with Liquid Nitrogen and Dry Ice Guideline

Section 1 - Purpose and Objectives

(1) This Guideline provides information on methods to minimise the likelihood of injuries and illnesses occurring from the use and storage of liquid nitrogen and dry ice. This Guideline has been developed to meet selected criteria of:

- a. [AS/NZS 2243.2-2006: Safety in Laboratories - Chemical Aspects](#); and
- b. [AS 1894-1997: The Storage and Handling of non-flammable cryogenic and refrigerated liquids](#).

Section 2 - Definitions, Terms, Acronyms

Terms	Definitions /Acronyms
LN	Liquid nitrogen
Dry ice	Solid carbon dioxide
SDS	Safety Data Sheet
OHS	Occupational Health and Safety
PPE	Personal Protective Equipment
SCBA	Self Contained Breathing Apparatus
SOP	Safe Operating Procedure
WHSC	Work Health and Safety Coordinator

Section 3 - Guideline Scope/Coverage

(2) This Guideline applies to all University workers and students who handle dry ice and liquid nitrogen.

Section 4 - Guideline Statement

(3) Cryogenic substances such as liquid nitrogen and dry ice are widely used throughout The University of Queensland. Cryogenic liquids and solids create significant risk to the health and safety of workers and students if not stored and handled correctly. This Guideline identifies the hazards and outlines the control measures.

Section 5 - Risk Management

Risk Assessments and Operating Procedures

(4) All tasks undertaken at UQ using cryogenic substances must have a thorough risk assessment carried out using

the [UQ Risk Management Database](#) with reference to the SDS, and be approved by the Supervisor prior to use. Higher risk management controls must be in place including specific plant and engineering requirements as outlined in [AS 1894 The Storage and handling of non-flammable cryogenic and refrigerated liquids](#).

Note: for practical purposes carbon dioxide gas from dry ice has no chemical reactivity issues as these reactions occur for carbon dioxide gas at elevated temperature and gas pressures.

Control of Risks for Liquid Nitrogen and Dry Ice

(5) Asphyxiation - all dewars and dry ice containers must be designed for purpose and must be located in well ventilated areas to allow for gas venting. Any transfer from the original storage should be into an appropriate transport container and workers and students must not be in a confined space such as lifts or small enclosed rooms where oxygen depletion may be an issue.

Note: This does not include the transport of small quantities of LN (1 litre or less) in elevators; this process has been risk assessed and found to be acceptable due to the small quantities of LN involved.

(6) Work with dry ice should be in a fume hood or appropriately ventilated area, and reaching over into a large dry ice esky should be avoided. Storage areas where oxygen displacement can occur must have an oxygen depletion alarm. Never store dewars of LN, samples packed in dry ice, or dry ice for re-use in walk-in cold rooms. Fainting caused by a pocket of low oxygen air can still cause serious injury, therefore samples containing dry ice should not be stored in chest or vertical fridge or freezers.

(7) Cryogenic burns - Where appropriate, PPE such as thermal gauntlet gloves, face shields/safety goggles/safety glasses, overalls and sturdy covered shoes must be worn to ensure cryogenic material does not come into direct contact with the body.

(8) Explosion from expanding vapours - Sealed containers should not be used to store either LN or dry ice and any sample containers used must be fit for purpose. Do not pour LN or dry ice into the drains as contact with water will increase the rate of gaseous products and the reduced temperatures may damage the drainage pipework.

(9) All bulk deliveries of dry ice or liquid nitrogen should be moved with the assistance of mechanical aids such as trolleys. Assisted lifting (using multiple people) should be considered for loading trolleys or pouring large quantities of liquid nitrogen.

(10) Embrittlement - carbon steel, plastics and rubber become brittle and fracture under stress when exposed to cryogenic temperatures. Storage vessels should be checked regularly for cracks and leaks and be replaced as required.

Additional Risk for Liquid Nitrogen

(11) Since the boiling point of liquid nitrogen is lower than liquid oxygen, oxygen enrichment can occur within areas of the liquid nitrogen storage system (such as cold traps). Ensure organic material is kept away from these areas to minimise the risk of fire or explosion. Cycle the temperature of the trap to allow accumulated liquid oxygen to boil away.

Storage and Transport

Dry Ice

(12) Styrofoam eskies are suitable for small quantities (less than 500g) of dry ice used to transport biological samples. Larger quantities of dry ice should be stored in purpose-built, vented eskies to reduce the rate of offgassing of carbon dioxide gas. Small amounts of dry ice, e.g. a single esky of biological samples, may be transported in lifts without

special precautions, as well as in vehicles provided fresh, makeup air is available.

(13) For dry ice quantities above 500g, a utility vehicle with a load area segregated from the passenger compartment will be suitable no matter what container type. The transport requirements for larger quantities in vehicles with shared load and passenger compartments will need to be determined by risk assessment.

(14) Consideration should also be given to the substitution of dry ice for road transport of perishable samples with a method that does not pose an asphyxiate gas risk. This includes:

- a. Transport with a refrigerated cooler brick, gel or wet ice if the samples are sealed from water intrusion.
- b. Lyophilisation (freeze drying) of the samples where morphological properties do not need to be retained.

Liquid Nitrogen

(15) Liquid nitrogen should be stored in containers specifically designed to contain cryogenic fluids. Dewars and pressurized vessels specifically designed for storage of liquid nitrogen, and samples, are the most commonly used containers for the storage of liquid nitrogen throughout The University of Queensland.

(16) All liquid nitrogen containers should be stored:

- a. in a stable manner and on a sturdy surface; and
- b. in a position that does not restrict access and egress; and
- c. in a position where they are unlikely to be knocked by persons or other equipment.

(17) [LN - Oxygen Depletion Calculations](#) should be carried out for each workplace used for storage and handling of liquid nitrogen.

(18) If the oxygen concentration in the laboratory is:

- a. Greater than 19.5% - acceptable.
- b. Between 18% and 19.5% - unacceptable. Implement control measures to increase oxygen concentration - increase ventilation and decrease the volume of liquid nitrogen used in the laboratory. A low oxygen alarm should be installed.
- c. Less than 18% - unacceptable. No person should enter the room without air supplied breathing apparatus (generally only emergency services personnel). If the room is to be kept at this concentration, a low oxygen alarm should be interlocked to the door to prevent access by unauthorized personnel.

(19) Regardless of oxygen concentration, the University requires that rooms containing more than 50 litres of liquid nitrogen (whether in pressurized vessels or dewars) should have a low oxygen alarm fitted to alert in the event of liquid nitrogen spills, and liquid or gas escapes.

(20) Specific ventilation controls include:

- a. Vents and relief valves of pressurized liquid nitrogen vessels should discharge to a safe place (not impinge on people, plant or structures) and should be connected to an extraction system that exhausts to a safe external location or recovery system.
- b. Where processes generate significant quantities of nitrogen gas, extraction ventilation should be used to remove nitrogen gas from areas where it can affect persons and exhaust it to a safe external location or recovery system.

(21) Lifts and Enclosed Spaces:

- a. For relocating liquid nitrogen dewars within and between buildings, a dewar on wheels or suitable trolley should be used. Goods or passenger lifts can be used, where available, to move containers between floors. Arrangements should be made so that no one accompanies vented dewars in a lift-lock out mechanisms or out-of-hours relocation of liquid nitrogen may be more appropriate under these circumstances.
- b. If containers of LN are to be transported by vehicle, a dry shipper (purpose-built vacuum flask that allows no LN to be spilt) should be used. Under no circumstances should liquid nitrogen be transported in an enclosed vehicle.

Training and Competency

(22) All personnel working at the University are required to complete two mandatory online safety inductions:

- a. The General Workplace Safety Training; and
- b. Annual Fire Safety Training.

(23) In addition, personnel working in laboratories and/or with chemicals are also required to complete training modules for Laboratory and Chemical Safety.

(24) These modules can be completed online as part of the UQ OHS training and assessment program. Please refer to the [online OHS training modules](#) webpage.

(25) Where large volumes of LN are handled and stored [SCBA Training](#) for emergencies will also be required.

Emergency Procedures

Spills and Contamination

(26) If a low oxygen alarm is activated, the room should be evacuated immediately. Do not allow re-entry to the area. Call Security and the WHSC for the area. SCBA trained WHSCs in the vicinity will be needed if there is a casualty, who has collapsed in the oxygen depleted atmosphere. Work colleagues who attempt rescue without using proper breathing apparatus (SCBA) are likely to succumb and become casualties themselves.

First Aid

(27) If a person is showing symptoms of mild or severe asphyxia, they should be removed to an area with fresh air. If they are unconscious remove them from the oxygen depleted zone, call Security and the local First Aid Officer and, if the casualty is not breathing, resuscitation must be started immediately.

(28) If the casualty has been contaminated with liquid nitrogen the affected clothing should be removed immediately to prevent further burning and any affected skin should be warmed using lukewarm water. For further information on cryogenic burns please refer to [First Aid Treatment for Burns Guideline](#). Professional medical advice at a hospital should always be sought urgently for significant cold burns and asphyxia.

Section 6 - Obligations

Supervisors

(29) Ensure that risks are eliminated or minimised as far as reasonably practicable.

(30) Provide supervision and training in the safe use of these materials.

(31) Provide assistance with the risk assessment process and ensure the assessment is comprehensive and accurate.

- (32) Review and approve the risk assessment, and ensure all controls outlined in the assessment are followed by workers.
- (33) Ensure that all appropriate safety systems and equipment are in place, fully operational and used correctly.
- (34) Ensure that all incidents involving these materials are investigated as soon as possible and that corrective actions (including review and modification of risk assessment and SOPs) are implemented to prevent recurrences.

Workers and Students

- (35) Ensure that risks are eliminated or minimised as far as reasonably practicable.
- (36) Provide assistance with the risk assessment process to help ensure the assessment is comprehensive and accurate.
- (37) Follow safe operating procedures and use the controls outlined in the risk assessment.
- (38) Wear all PPE required and ensure it is maintained in good condition.
- (39) Immediately stop work and notify the Supervisor if there are any changes to procedures or deficiencies in the work process or risk assessment.

Section 7 - References

- (40) [Safe Work Australia - Guidance on the interpretation of Workplace Exposure Standards for Airborne Contaminants](#). Australian Government Publishing Service: Canberra.
- (41) Standards Australia (1997) [AS1894-1997: The storage and handling of non-flammable cryogenic and refrigerated liquids](#). Standards Australia: Sydney.
- (42) Standards Australia (2006) [AS/NZS 2243.2-2006: Safety in laboratories - Chemical aspects](#). Standards Australia: Sydney.

Section 8 - Contact for Additional Information

(43) UQ Occupational Health and Safety Unit
Occupational Hygiene Advisor
Email: ohs@uq.edu.au

Status and Details

Status	Current
Effective Date	20th May 2015
Review Date	20th May 2018
Approval Authority	Director, Health Safety and Wellness
Approval Date	20th May 2015
Expiry Date	Not Applicable
Policy Owner	Jim Carmichael Director, Health Safety and Wellness
Enquiries Contact	Health, Safety and Wellness Division