



Safe Use of Liquid Nitrogen (and other Cryogenic Fluids)

Purpose

This guideline provides advice on how to ensure that hazards from the storage, transportation and handling of liquid nitrogen and other cryogenic fluids are well managed and risk of injury or illness to personnel is eliminated or mitigated.

Scope

This guideline relates to liquid nitrogen and other cryogenic fluids that are stored in either fixed or portable vessels.

General

Liquid nitrogen and other cryogenic fluids that affect the content of oxygen in air can result in life threatening asphyxia which can be sudden (immediate) or gradual (over a few minutes or hours). Either situation can result in death. There is also potential for anyone attempting a rescue of being exposed to low levels of oxygen and becoming a subsequent casualty. The level of oxygen in air should be not less than 19.5% to sustain life.

Contact with cryogenic fluids, vapour or gas at cryogenic temperatures can produce an effect on the skin similar to a burn. The severity depends upon the temperature of the liquid and the exposure and can result in frostbite.

Either of the above situations requires immediate medical attention.

Definitions

Asphyxia – the condition that arises when the blood is deprived of an adequate supply of oxygen.

Dangerous Goods Class – the number assigned to dangerous goods that exhibit a common single or most significant risk, determined in accordance with UN *Manual of Tests and Criteria* and listed in the Australian Dangerous Goods (ADG) Code.

Cryogenic fluid – a liquid having a normal boiling point below minus 90°C at atmospheric pressure (101 kPa).

Dangerous Goods – substances and articles that:

- a) satisfy the tests and criteria for determining whether they are dangerous goods as specified in the UN *Manual of Tests and Criteria* or the UN *Recommendations on the Transport of Dangerous Goods*, or are listed in the ADG code.
- b) are determined to be dangerous goods by the competent authority.

Dewar flask – a portable, double-walled container, which is normally open-necked, free-venting and non-pressurised, and is used for storing liquefied gases at low temperature.

Full Gas Volume – the total volume, which the gas, in a nominally full vessel, will occupy when expanded at 15°C and 101.325 kPa.

Inert – for the purposes of this procedure the term 'inert' is defined as non-flammable and non-toxic.

Installation – all of those facilities on a site that are related to the storage or handling of cryogenic and refrigerated liquids.

Manifest – a written summary of the hazardous chemicals used, handled or stored.

Safety Data Sheet (SDS) (or Material Safety Data Sheet (MSDS)) – contains information on the identity of a product and any hazardous ingredients, potential health effects, toxicological properties, physical

hazards, safe use, handling and storage, emergency procedures, and disposal requirements specific to the chemical.

Secured Area – storage area appropriately secured against access by unauthorized persons.

Shall – indicates that a statement is mandatory.

Should – indicates that a statement is a recommendation.

Roles

Executive Deans and Directors of Research Institutes are to ensure that:

- This guideline is followed in their area of responsibility and necessary resources are provided to support implementation
- Supervisors are aware of legal requirements and safe work practices associated with liquid nitrogen and other cryogenic fluids
- Appropriate storage facilities and means of transportation are provided
- Incidents are investigated and advised to external authorities as appropriate using an online Hazard or Incident Investigation Report
- Provisions are in place to ensure appropriate response in the event of an emergency.

Managers & Supervisors – (including Principal Investigators, all academic and professional staff who supervise staff or students, Laboratory Technicians and Managers, Demonstrators, Academic Supervisors) are to ensure that:

- They have received training or instruction on safe work practices for storage, transport and handling of liquid nitrogen or other cryogenic fluids to allow effective supervision of users within their area of responsibility
- All people who use liquid nitrogen or other cryogenic fluids have received training or instruction on safe work practices for storage, transport and handling, and comply with those practices
- Risk assessments are carried out for procedures involving the use of liquid nitrogen or other cryogenic fluids
- All vessels containing liquid nitrogen comply with the appropriate Australian Standard (AS 1894-1997) and are appropriately labelled
- All people who use liquid nitrogen or other cryogenic fluids are advised of emergency and first aid procedures in the event of an emergency
- Safety data sheets (SDS) are current and displayed in the vicinity of where liquid nitrogen or other cryogenic fluids are used.

Staff and Students – (including Students, Higher Degree by Research Students, Research Assistants and Research Officers) are to ensure that:

- They don't place themselves or others at risk of injury or illness when storing, transporting or handling liquid nitrogen or other cryogenic fluids
- They do not use liquid nitrogen or other cryogenic fluids unless trained and competent
- They comply with safe work procedures
- They are familiar with the physical and chemical properties of liquid nitrogen or other cryogenic fluids and the information provided in the SDS including first aid measures
- They report any unsafe practices or incidents to their supervisor.

Safety & Wellbeing consultants and other safety officers are to:

- Provide advice on the implementation of this procedure
- Identify any barriers to compliance and provide advice and guideline on addressing the barriers
- Provide information and training to personnel where non-compliance with safe work procedures is identified in order to achieve compliance
- Escalate continued non-compliance with supervisor or manager as appropriate.

Procedure

a) Purchasing

- i) Completion of the **WHS12** checklist is required prior to purchase to enable the management of any risks to be planned.
- ii) Chemwatch are to be advised if the *GoldFFX* database does not include an SDS for a newly purchased cryogenic fluid.

b) Risk Assessment and Control including Personal Protective Equipment

- i) Risk assessments must be undertaken and appropriate control measures implemented, monitored and adjusted as needed. Employees must be provided with a genuine opportunity to contribute to the risk assessment process.
- ii) Personal protective equipment (PPE) shall be worn and must not hamper the user's ability to handle the cryogenic fluid safely. PPE shall cover skin and eyes e.g. lab coat or gown and a visor, in a manner that allows for easy removal in the event of a spill. PPE must not hold the cryogenic fluid, but allow it to run off. Shorts and skirts are not acceptable, clothing must cover entire legs and arms. Shoes must be worn to cover all surfaces of feet, open toe shoes are not acceptable. Gloves must be specifically designed to handle cryogenic fluid, cotton or latex gloves are not acceptable. The UniSA risk assessment tool for chemical risk assessment can be found on the Safety & Wellbeing website: **WHS12**
- iii) Any storage indoors needs to have a risk assessment to determine if oxygen levels could be depleted in that area.

c) Access

- i) Only authorised and trained personnel shall have access to bulk storage areas and must not provide entry to unauthorised persons. Access is controlled by use of the Cardax system or keyed locks limiting access to personnel who have been trained and authorised. A list of trained people is kept, next to the liquid nitrogen supply in each Academic Unit or Research Institute.
- ii) Entry points to storage areas must be kept clear to allow for emergency access or egress, and clear access to fire fighting equipment and housekeeping equipment located nearby. Information on the location and quantities stored should be supplied to the Campus Facilities Manager to be included in a building and/or campus manifest kept within ready access of emergency personnel in the event of an incident.

d) Bulk Storage

- i) Site (preferably outside) to allow for adequate venting of gas when liquid nitrogen or other cryogenic fluids are being decanted
- ii) Placards are displayed indicating WARNING RESTRICTED AREA, AUTHORISED PERSONNEL ONLY
- iii) If stored internally without ventilation, an alarm shall be fitted to eliminate the risk of a person entering a room with insufficient oxygen to sustain life (if further information is required contact your WHS consultant or the Safety & Wellbeing team)
- iv) Adequate venting must be provided where liquid nitrogen or other cryogenic fluids are stored or used
- v) Venting shall not occur into an area where people may congregate or otherwise inadvertently be exposed to venting gas
- vi) Liquid nitrogen or other cryogenic fluids shall be stored on a level surface and secured in such a manner as to prevent accidental falling of the storage vessel
- vii) Adequate lighting must be provided in and around storage areas to ensure personnel are able to read labels and signs as needed
- viii) SDS must be displayed in the vicinity of the liquid nitrogen or other cryogenic fluids.

e) Labelling

- i) Shall be clearly marked to show the liquid for which the vessel or equipment is designed and used. Marking shall be in accordance with AS 1319:1994 *Safety signs for the occupational environment* and placarding in accordance with regulation 350 of the Work Health and Safety Regulations, 2012.

These labels can be printed from *GoldFFX*

- a. The proper shipping name
- b. The UN number
- c. The Hazchem code
- d. The Class label and subsidiary risk label.

f) Dispensing / Decanting

- i) An area shall be designated for safe filling of vessels from a delivery vehicle ensuring the area has a level surface, a quick exit can be made by the vehicle in the event of an emergency, and no parking is allowed on delivery days for other vehicles
- ii) Suitable warning signs shall be used during the process of filling vessels
- iii) Access to the filling area shall be strictly controlled with no access for unauthorised persons. Precautions must be taken to prevent spillage.
- iv) Personal protective equipment (long sleeves, long pants, gloves (specifically designed to handle cryogenic fluids), dust coat, enclosed shoes and visor) must be worn and all exposed skin covered, to prevent injury in the event of a spill.

g) Transportation / Conveying

- i) Only containers that have been specifically designed for transportation shall be used
- ii) Only trolleys that have been specifically designed for moving the containers shall be used
- iii) When using a trolley for external transportation consideration of the conditions (quality of the path and/or road surface and current weather) shall be made
- iv) People shall not travel in lifts with liquid nitrogen or other cryogenic fluids to eliminate any risk of asphyxiation in the event of a spill. Lifts shall be locked out to ensure no person inadvertently enters the lift during transit with liquid nitrogen or other cryogenic fluids
- v) Signage is placed on lift doors and in Liquid Nitrogen or other cryogenic fluid storage sites indicating that people must not travel in lifts with cryogenic fluids
- vi) Transportation (eg between campuses or delivery to campus) shall only be undertaken by an appropriately licensed carrier in accordance with the requirements of the Dangerous Substances (Dangerous Goods Transport) Regulations 2008.

h) Handling / Use

- i) All containers must be compatible with cryogenic liquids to prevent embrittlement
- ii) Containers must not be dropped
- iii) Any cap supplied with the container shall be:
 - i. Fitted when the contents of the flask are not in use and
 - ii. Sufficiently loose-fitting, or otherwise vented, to prevent pressure build-up
- iv) Where processes that generate large amounts of gas such as food freezing, freezing of tissue samples or cells are conducted indoors, the gas produced shall be vented by mechanical means into the atmosphere away from areas where people work or congregate
- v) Personnel using liquid nitrogen or other cryogenic fluids must familiarise themselves with the SDS.

i) Disposal

- i) Vessels belonging to an external supplier shall be returned when no longer required
- ii) Disposal shall not take place into trenches, pits, drains or confined spaces, or near people. Release or disposal of large quantities is to be done only after consultation with the supplier.

j) First Aid

- i) A suitable first aid kit and instructions from the SDS shall be provided in the vicinity of the user
- ii) First aid officers shall be educated in the first aid measures required in the event of an injury involving a cryogenic fluid and all other officers in the vicinity should know where the first aid instructions are displayed.

k) Spill Management

- i) Compliance with standard spill management outlined in the **Safe Management of Chemicals** procedure.

l) Emergency Management

- i) A plan must be in place to combat an emergency situation, developed in liaison with the Campus Facilities Manager and shared with emergency services. The plan should include action to be taken in the event of a fire, spill, explosion, leak or other emergency consistent with the **Emergency Management** procedure.
- ii) Information must be displayed at suitable locations to indicate to emergency services the location of the emergency plan, the manifest, PPE, essential services and the controls for their distribution.

m) Training

- i) All personnel involved with the transport, storage, handling and disposal of liquid nitrogen or other cryogenic fluids are trained in, and are competent with, safe work procedures. Refresher training is provided in accordance with every level of risk as identified through risk assessment process.

n) Record Keeping

- i) Records of training must be kept centrally and in local personnel records. Records of training in safe operating procedures should be kept locally.

o) Cleanliness

- i) Areas must be kept very clean to prevent contact with oil, grease and combustible materials which can be hazardous as liquid nitrogen can absorb atmospheric oxygen thus becoming oxygen enriched and increasing risk in the event of fire;
- ii) Only suitable solvents and cleaning procedures, as recommended by the supplier of the cryogenic fluid, are to be used.

University Resources

For further advice on managing risks in university workplaces, including procedures, guideline, forms and training courses, please visit the [Safety & Wellbeing website](#).

- WHS Procedure - Managing Workplace Health and Safety Risks
- WHS Procedure - Safe Management of Chemicals
- WHS12 – Chemical Process Risk Assessment and Control

Facilities Management Unit, [University Emergency Management Online Hazard/Incident Reporting & Investigation System](#)

References

[SafeWork SA Resources](#)—WHS legislation and Approved Codes of Practice:

- Work Health and Safety Act 2012
- Work Health and Safety Regulations 2012
- How to Manage Work Health and Safety Risks
- Managing Risks of Hazardous Chemicals in the Workplace

Government of South Australia, [Dangerous Substances Act 1979](#)

National Transport Commission, [Australian Code for the Transport of Dangerous Goods by Road or Rail \('ADG Code'\)](#)

[Australian Standards online](#) (UniSA subscription)

- AS 1894 -1997, *The storage and handling of non-flammable cryogenic and refrigerated liquids*.
- AS 1319:1994, *Safety signs for the occupational environment*.

(Note: This may not be a complete list of applicable Australian Standards)