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TECHNICAL INFORMATION SHEET 27

RISK ASSESSMENT GUIDANCE FOR THE SAFE USE OF LIQUID NITROGEN DEWARS

INTRODUCTION

Dewars containing liquid nitrogen (and other cryogenic liquids) are frequently used in the workplace and are occasionally transported by road, they have a very good safety record. BCGA Code of Practice 30 [3], *The safe use of liquid nitrogen dewars*, provides 'safe use' best practice for liquid nitrogen dewars.

This document provides guidance when carrying out a risk assessment on the specific hazards associated with using dewars containing liquid nitrogen. This risk assessment guidance should be read in conjunction with BCGA CP 30 [3]. This document does not constitute a comprehensive assessment of all workplace hazards as required under the *Management of Health and Safety at Work Regulations* [1] and additional specific risk assessments may be required, for example, for manual handling, slips, trips, falls, etc.

NOTE: The principles in this guidance can be applied to the use of other cryogenic liquids, such as helium, argon and oxygen, however, the specific properties of the individual gas should be assessed before its use. You should always check with a competent person. As required, seek the advice of your gas supplier.

The storage and use of liquid nitrogen in a bulk tank is outside of the scope of this document, refer to BCGA CP 36 [4], *Cryogenic liquid storage at Users' premises*. However, the process of operating the source tank to fill a dewar should be considered in your overall risk assessment.

Employees handling liquid nitrogen using dewars are likely to encounter one or more of the following significant hazards:

- a release of nitrogen gas, resulting in oxygen depletion, potentially creating an asphyxiant atmosphere;

- a release and / or contact with the liquid, resulting in cold burns; rapid increase in nitrogen gas; reduced visibility and the potential for slips, trips and falls;

- a build-up of pressure, resulting in loud noise (operation of relief devices) or from blockages caused by excessive ice, which in extreme cases could lead to failure of the dewar.

NOTE: Liquid nitrogen is valued for its cold properties. This is best achieved by maintaining the stored liquid at atmospheric or under low pressures. If the pressure is allowed to build the temperature will rise.

This document will assist in conducting a risk assessment, the Health and Safety Executive (HSE) provide useful information at http://www.hse.gov.uk/risk/.

The basic principles of conducting a risk assessment require:

- identifying the potential hazards in the workplace;
- identifying who might be harmed and how;
- evaluating the risks and deciding on appropriate control measures, taking into account control measures already in place;
- recording the risk assessment;
- reviewing and updating the risk assessment.

During the risk assessment any potential damage to property and harm to the environment should also be considered. Refer to HSE INDG 163 [2], *Risk assessment. A brief guide to controlling risks in the workplace.*

Using dewars containing liquid nitrogen is a hazardous activity and will require a suitable and sufficient risk assessment. The risk assessment carried out should be recorded in an appropriate format, for example, those published by the HSE.

Only persons who are competent under the *Management of Health and Safety at Work Regulations* [1] shall undertake risk assessments. This competence includes sufficient knowledge of liquid nitrogen, associated activities and the specific workplace.

SPECIFIC HAZARDS

The specific hazards to be considered are:

- asphyxiation;
- cold contact;
- hypothermia;
- pressure release;
- embrittlement, through changes to material properties.

1. Asphyxiation

Asphyxiation is caused by a lack of oxygen. The level of oxygen in the local atmosphere can be reduced from the release of nitrogen gas by the following:

- continuous evaporation of the liquid nitrogen in the dewar irrespective of the activity;

- increased evaporation caused by liquid agitation during, for example, movement of a dewar;

- increased evaporation during transfer, for example, from a dewar to another container;

- evaporation following liquid spillage;

- pressure relief device operation (if fitted) – regular venting and the potential for inadvertent release of nitrogen.

The size of the area, the level of ventilation and the quantity of liquid nitrogen will impact the risk from asphyxiation.

As a minimum the risk assessment should consider the following:

- the level of ventilation where liquid nitrogen is stored, filled, transported and used;

- the quantity of liquid nitrogen;

- suitability of the equipment for the task;

- maintenance of equipment;

- the activity;

- competency of personnel;

- health effects, including on those with a pre-existing health condition;

- management of the local area.

Conduct a risk assessment to determine if there is adequate ventilation for the quantity of liquid nitrogen to prevent an asphyxiant atmosphere being created, refer to BCGA GN 11 [5], *The management of risk when using gases in enclosed workplaces.*

As necessary, implement appropriate control measures, refer to BCGA CP 30 [3].

2. Cold contact

Liquid nitrogen is extremely cold, at a temperature of -196 °C. Exposure to low temperature can be harmful, either from the liquid or indirectly from the effects of the cold environment created. This includes:

- Direct contact with skin or tissue.

  Contact with liquid or cold gaseous nitrogen, or objects that have become cold-soaked, may result in frostbite and / or cold burns. Severity will be dependent on the exposure time. Cryogenic liquids and vapour can also damage the eyes.

  A cold burn has similar effects to a burn caused by high temperatures and can be more severe due to the effects of numbing.

- Prolonged proximity to the cold, resulting in hypothermia. Refer to Section 3.

- Inhalation.

  Inhalation of either the cold nitrogen gas, or the local cold atmosphere can damage the lungs and is likely to aggravate existing health conditions. The severity is dependent on the temperature and exposure time.

- Ingestion.

  Ingestion of liquid nitrogen will cause severe damage to internal organs, it is likely to be fatal.

Cold contact can occur as a result of:

- a release of liquid nitrogen;
- the activity;
- the local environment;
- contact with cold soaked articles;
- inadequate or inappropriate personal protective equipment.

As a minimum the risk assessment should consider the following:

- spillage(s) and splashing;
- the level of ventilation;
- system of work;
- the type and suitability of the equipment for the task;
- examination, inspection and maintenance of equipment;
- competency of personnel;
- health effects, including on those with a pre-existing health condition;
- management of the local area;
- human factors and ergonomics;
- emergency response (including first aid);
- residual risk and, if necessary, selection and maintenance of appropriate personal protective equipment.

As necessary, implement appropriate control measures, refer to BCGA CP 30 [3].

3. Hypothermia

Hypothermia occurs due to the body being unable to maintain its normal temperature due to prolonged exposure to low temperatures. The dangers of hypothermia may be present at temperatures below 10 °C (283 K).

The boiling point of liquid nitrogen at atmospheric pressure is -196 °C (77 K) and evaporated gas will emerge at this temperature, affecting the local ambient temperature.

Hypothermia can occur as a result of:

- prolonged exposure to cold environments;
- inadequate or inappropriate personal protective equipment.

All individuals will have different physiological outcomes.

As a minimum the risk assessment should consider the following:

- spillage(s) (including vapour clouds);
- duration of activity;
- working environment;
- maintenance of equipment;
- management of the local area;
- health effects, including on those with a pre-existing health condition;
- human factors;
- emergency response (including first aid);
- residual risk and, if necessary, selection and maintenance of appropriate personal protective equipment.

As necessary, implement appropriate control measures, refer to BCGA CP 30 [3].

4. Pressure

Liquid nitrogen continuously evaporates. It will change from a liquid to a gas with an expansion ratio of approximately 1 : 700. Normally a properly designed and operated dewar is open to the atmosphere and therefore, the risk of harm from pressure is low. However pressure may build up in a dewar if:

- a liquid withdrawal device is fitted.

This will create a small pressure of typically up to 0.5 bar. A properly designed and maintained pressure relief device will control and relieve any excess pressure.

- an ice plug occurs.

Ice will form from atmospheric moisture, for example, from mist, rain, snow, etc., which comes into contact with the cold temperatures found in the neck or the top of the opening into the dewar. An ice plug may form if left unchecked. An ice plug can form a seal which will prevent the release of gas.

- the rate of liquid nitrogen evaporation exceeds the rate to which it can release to atmosphere.

A properly designed and maintained dewar lid or cap will be a loose or nominal fit which will allow some pressure to be released. Incorrectly fitting, or badly secured lids or caps, which are too tight will allow an increase in pressure to occur, if they are too loose they may allow the formation of ice. Poor storage, such as allowing objects to be placed on a dewar lid, for example, boxes, shall be prevented as this may result in a dangerous increase in pressure.

The rate of evaporation will increase due to a reduction in the efficiency of the dewar insulation, or the location of a dewar near a heat source, resulting in an increase in pressure.

Direct contact with pressure can cause damage to eyes, or create a gas embolism (bubbles in the blood circulatory system). Indirect pressure can cause objects or the liquid / gas to move, contact or penetrate the body.

As a minimum the risk assessment should consider the following:

- the potential for pressure build up;
- the type and suitability of the equipment for the task;
- maintenance of equipment;
- activities;
- competency of personnel;
- management of the area, including the location of the dewar;
- emergency response, for example, in the event of an ice blockage;
- residual risk and, if necessary, selection and maintenance of appropriate personal protective equipment.

As necessary, implement appropriate control measures, refer to BCGA CP 30 [3].

5. Embrittlement - Changes to material properties

The extreme cold of liquid nitrogen can cause embrittlement and subsequent failure of certain materials, for example, carbon steel, plastics, polymers.

NOTE: If liquid nitrogen is spilled, any objects or materials that came into contact with the liquid nitrogen should be checked for damage.

A properly designed and manufactured dewar will be capable of safely holding liquid nitrogen.

Embrittlement of non-compatible materials may occur when in contact with liquid nitrogen:

- following a spillage;
- on immersion;
- during decanting.

As a minimum the risk assessment should consider the following:

- compatibility and suitability of materials;
- activities;
- competency of personnel;
- management of the area, including the location of the dewar;
- emergency response.

As necessary, implement appropriate control measures, refer to BCGA CP 30 [3].

REFERENCES

1) SI 1999 No. 3242, Management of Health and Safety at Work Regulations 1999.
2) HSE INDG 163, Risk assessment. A brief guide to controlling risks in the workplace.
3) BCGA CP 30, The safe use of liquid nitrogen dewars.
4) BCGA CP 36, Cryogenic liquid storage at Users' premises.
5) BCGA GN 11, The management of risk when using gases in enclosed workplaces.

For more information

Health and Safety Executive (HSE) www.hse.gov.uk
British Compressed Gases Association (BCGA) www.bcga.co.uk