

## Code of Practice E: Use of Cryogenics

### 1. Gases and Cryogenics in Enclosed Areas

Suitable ventilation should be ensured when using gases and cryogenics to prevent oxygen depletion. Atmospheres containing < 18% oxygen are potentially dangerous. The risk of unconsciousness followed by brain damage or death due to asphyxia is greatly increased at oxygen levels below 10%. Cryogenics produce large volumes of gas. For example 1.5 litres of liquid nitrogen will reduce oxygen levels to below 18% in a typical lift (see **Section G**).

**Do not travel or allow anyone else to travel in a lift with cylinders of gases or cryogenics.**

### 2. The Use Of Liquid Nitrogen As A Coolant

#### (a) LIQUID NITROGEN - PERSONAL PROTECTION

##### (UHSS Topic A-Z/Cryogenics)

The Department supplies liquid nitrogen, which boils at 77 K (−196 °C), chiefly in metal vacuum flasks (Dewar vessels), each holding 25 dm<sup>3</sup>.

#### (i) Burns

Prevent splashes reaching your face and hands by wearing goggles and gloves. The gloves: (a) should be loose-fitting, so that you can shake them off if coolant finds its way to your hands; and (b) should not be rubber (which becomes embrittled at very low temperatures). Clothing should be worn such that spilled coolant runs off immediately; do not allow the coolant to come to rest long enough to burn your skin. Visors or face shields with appropriate EN166 classification may also be used for added protection.

#### (ii) Vaporisation in a confined space

Do not cork or seal any vessel containing liquid nitrogen. It is boiling continually and the vaporisation produces a seven-hundredfold increase in volume, so a sealed vessel will explode.

#### (iii) Asphyxiation

A room where liquid nitrogen is evaporating should have a good supply of fresh air so that the proportion of oxygen in the atmosphere is kept above the minimum (19.5%) for normal human comfort. Oxygen monitors should be used if the ventilation is insufficient.

**Do not travel or allow anyone else to travel in a lift with liquid nitrogen.**

#### (iv) Thermal shock to vessels

Introduce coolant around or into a glass vessel slowly so that sudden thermal stresses are not set up in the glass. In time, Dewar vessels of glass that are subjected often to coolant will succumb to the repeated stress by imploding, so you should guard in advance against flying glass from an implosion by covering all exposed glass surfaces of such vessels with adhesive tape or appropriate plastic netting.

#### (b) CHEMICAL HAZARD

Liquid nitrogen-cooled **open vessels** are cold enough to condense oxygen from air in the atmosphere. You should be aware that liquid oxygen, despite its coldness, is chemically reactive, particularly towards some organic substances.

Further information on freeze-pump-thaw/degassing solvents, which involves liquid N<sub>2</sub> and vacuum lines, can be found in Code of Practice F.

### 3. The Use of Solid Carbon Dioxide ('Dry Ice')

1 kg of solid CO<sub>2</sub> will produce 0.45 m<sup>3</sup> of gas and the sublimation rate is approximately 1% of total mass per hour in an insulated container, rising to 14% per hour at room temperature in the open.

- (a) In order to avoid burns, wear insulated gloves. Do not handle with bare hands.
- (b) When adding solid CO<sub>2</sub> to organic solvents, for example when preparing traps or cold fingers, the initial rate of CO<sub>2</sub> addition to the warm (room temperature) solvent should be slow to avoid solvent being expelled from the trap by the vigorous boil off.
- (c) Carbon dioxide differs from other asphyxiant gases in that raised levels can be sensed and will cause discomfort or more serious consequences. The normal CO<sub>2</sub> level is 0.0003%. At 1% CO<sub>2</sub>, there will be a slight, unnoticeable increase in breathing rate; at 5–10%, breathing becomes laboured at a rate up to twice the normal rate, hearing ability is reduced, headaches develop, blood pressure and pulse rate increase, and sensory disturbances (visual, auditory) develop, leading to confusion and ultimately a loss of consciousness within minutes. **Concentrations of 20% and above are immediately hazardous to life, even without oxygen depletion.**

**Never take solid CO<sub>2</sub> into a confined space**, such as a lift, a controlled temperature room or the passenger compartment of a car (see **Section G** for the definition of a confined space).

### 4. Emergency Measures

- (a) In the event that you discover someone unconscious in a confined space (**Section G**) that contains cryogenics or gas cylinders, **do not enter the room**. First, call the emergency services (9-999) and then seek assistance from the CHEMBAT (breathing apparatus) team (**Section B**).
- (b) Unprotected parts of the body that come into contact with uninsulated, cold equipment may be freeze-welded to it and be torn on removal. Because of the rapidity of damage to nerves, there may well be little warning through localised pain. All cold burns should be checked by a first-aider or by a medical expert in extreme circumstances, to confirm the extent of damage.