BioEscalator COSHH 007: **Correct use of Dry Ice**
Cross Ref. to University of Oxford Guidance Note: S4/03 and BOC safety data sheet

General Uses

Used as a cooling / freezing agent in laboratory procedures or for transportation of samples.

Properties and Hazards

- Solid form of CO_2 – very cold (-78^0 C), contact with product may cause severe cold burns or frostbites. Asphyxiant in high concentrations.
- Normally supplied as pellets, flakes or blocks.
- Sublimes (changes state from solid to gas – the product will not melt to a liquid)

Properties and Risks

- Cold burns due to skin contact.
- Asphyxiation due to sublimation and accumulation of gas in poorly ventilated areas.
- Colourless gas.
- Present in the air we breathe at a concentration of approximately 300ppm (parts per million) or 0.03%.
- Odourless at low concentrations but characteristic odour at higher concentrations (see Table 2).
- Non-flammable – though like any other compressed gas, exposure to fire may cause the cylinder to rupture or explode.
- The gas / vapour is heavier than air – relative density = 1.52 (air = 1). May accumulate in confined spaces, particularly at or below ground level.
- Capable of causing asphyxiation at high concentrations (see Table 2).
- Though CO_2 is a non-toxic gas, it does have an occupational exposure limit assigned to it under the *Control of Substances Hazardous to Health Regulations* as indicated in Table 1.

Table 1

Workplace Exposure Limit	Concentration (ppm)	Concentration (%)
Short Term Exposure Limit (STEL)	15,000	1.5
Long Term Exposure Limit (LTEL)	5,000	0.5

Occupational Exposure Standards are set to help protect the health of workers and represent the concentrations of hazardous substances in the air averaged over a specific time period (time weighted average – TWA). Two time periods are used: long term (8 hours) and short term (15 minutes). The long term limit of 8 hours represents a typical working day, whilst the short term limits are set to help prevent effects which some substances may have following only a few minutes of exposure e.g. eye irritation. The effects and symptoms of CO_2 exposure are summarised in Table 2.

Table 2

ppm	% Vol	Effects and Symptoms
10,000	1	Slight but un-noticeable increase in breathing rate.
20,000	2	Breathing becomes deeper – rate increases to 50% above normal. Prolonged exposure (several hours) may cause headache and exhaustion.
30,000	3	Breathing becomes laboured. Hearing ability reduced, headache experienced with increase in blood pressure and pulse rate.
40-50,000	4-5	As above. Signs of intoxication after 30 minutes exposure and slight choking sensation.
50-100,000	5-10	Characteristic pungent odour noticeable. Breathing very laboured leading to physical exhaustion. Headache, visual disturbance, ringing in the ears, confusion probably leading to loss of consciousness within minutes.

100,000+	10+	Rapid loss of consciousness with risk of death from respiratory failure.

- Explosion due to pressure build up if kept in sealed containers.
- Manual handling of large bags of dry ice (10kg is the standard package weight).

Assessment of Potential for Gas Release

It is difficult to evaluate the rate at which the solid form will convert to the gaseous form since this will be dependent on a number of variables:

- The form of the dry ice – pellets or flakes, for instance, will sublime at a faster rate than blocks.
- The ambient temperature – sublimation will proceed faster at higher temperatures.
- The degree of insulation provided by the container.

However, the data below can be used to make some approximate estimates as to what concentration of gas will be generated in particular circumstances.

- 1kg of dry ice will produce 0.45 m^3 of gas (figure supplied by Gas Safety UK Ltd.).
- Dry ice to CO_2 sublimation rate = approx. 1% of total mass per hour in an insulated container (figure supplied by Gas Safety UK Ltd. - source: Federal Aviation Administration in USA).
- Dry ice to CO_2 sublimation rate = approx. 14% of total mass per hour at room temperature in the open (figure supplied by Gas Safety UK Ltd. - source: a study published in Aviation, Space and Environmental Medicine 1977).

Control Measures

- Do not handle with bare hands – use PPE- wear cold insulated gloves and safety glasses or face-shield to EN166. Wear apron or protective clothing in case of contact.

- Avoid carrying dry ice in the cab of a truck or the passenger compartment of a car. If this is not possible, use as little dry ice as possible, ensure that the container is well insulated (though not tightly sealed) and ensure that the compartment is well ventilated (open windows, ensure ventilation system is set to draw fresh air from outside).
- Unload the material as soon as possible at the end of a journey.
- Store dry ice in well ventilated areas away from direct sunlight and sources of heat.
- Use suitable storage containers (there are commercially available insulated containers with vented seals specifically designed for storing dry ice) in well ventilated place. Keep container below 50°C. Protect containers from physical damage; do not drag, roll, slide or drop.
- Secure to prevent any unauthorised access.
- Use appropriate warning signage where necessary.
- When opening lids to storage containers, allow a few seconds for gas to dissipate and do not lean in for longer than necessary.
- Do not store or use dry ice in any gas tight container.
- Do not store dry ice in a working refrigerator or freezer – it will sublimate at a faster rate than in an insulated storage container and the extremely cold temperature may cause the thermostat to cut out.
- Dispose of unwanted dry ice by allowing it to evaporate in a well ventilated area – it will sublime leaving no residue or return to the cardice box in the freezer room on level 1.
- Carry out manual handling assessment of bags if necessary.
- Ensure that all users of dry ice are familiar with the hazards and necessary precautions.

For transporting samples in dry ice, see also Dangerous Goods Transportation.

First Aid Measures

Inhalation:

Low concentration of CO2 cause increased respiration and headache. In high concentrations may cause asphyxiation. Symptoms may include loss of mobility/consciousness. Victim may not be aware of asphyxiation. Remove the victim to the uncontaminated area wearing self-contained breathing apparatus. Keep victim warm and rested. Call a doctor. Apply artificial respiration if breathing stopped.

Eye Contact:

In case of frostbite spray with water for at least 15 minutes. Apply a sterile dressing. Get medical attention.

Skin Contact:

In case of frostbite spray with water for at least 15 minutes. Apply a sterile dressing. Get medical attention.

Ingestion:

Swallowing must be absolutely avoided, since coldness and developing pressure could be dangerous. Obtain medical attention.

Emergency Procedures

Temperature related

- For brief, localised contact with cold material - flush the area with tepid water. (Water is used because of its high heat capacity.) Obtain **First Aid** assistance.

Accidental Release Measures

- Evacuate the area. Provide adequate ventilation. Prevent from entering sewers, basements and workpits, or any place where its accumulation can be dangerous. Wear self-contained breathing apparatus when entering area unless atmosphere is proved to be safe. EN137 respiratory protective devices – self-contained open-circuit compressed air breathing apparatus with full face mask.