Working safely with liquid cryogens

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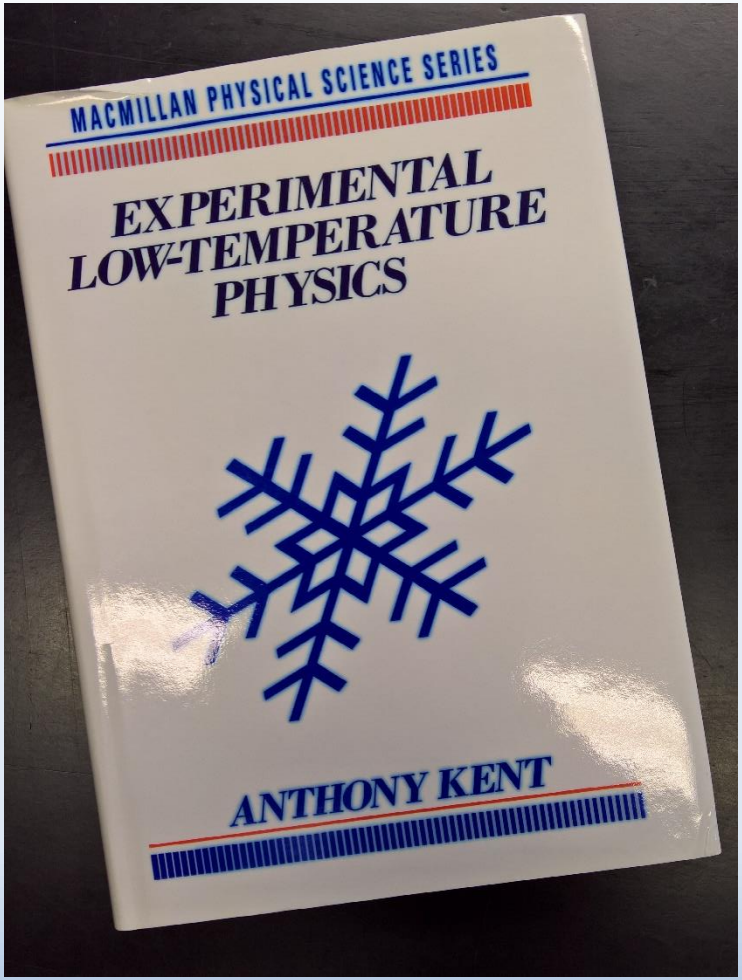
- Together over 50 years experience working safely with liquid cryogens in research and technical roles.

- No known long-term health hazards from working with liquid cryogens.

- With good practice and common sense approach, using liquid cryogens is a low-risk activity.



• Management of health and safety at work is based on the process of ***risk assessment***:

•First we must identify the ***hazards*** associated with a work process. These describe the ways in which a process or agent used may potentially cause harm to persons or property. For liquid cryogens these are:

1. Damage due to contact with substances/objects at extremely low temperature
2. Explosion due to build-up of high pressures in containers
3. Oxygen displacement leading to asphyxiation
4. Fire

- When we have identified the hazards we need to assess the ***risk***, that is the likelihood that the harm from a particular hazard is realised, and also takes account of the severity of the consequences.

- Risk is situation specific, i.e. for liquid cryogens it will depend on the application, quantity and frequency of use.

- Local risk assessments must be carried out to identify the risks, and put in place safe systems of work to minimise them.

- **In this talk we will explain and demonstrate the hazards associated with work with liquid cryogens and give some recommendations that you may use when devising safe systems of work.**

The hazard of extreme low temperatures

- Boiling points at atmospheric temperature:
  Liquid nitrogen – 77 K (-196 C)
  Liquid helium – 4.2 K (-269 C)

- Metal is a good thermal conductor so the outside of a metal pipe carrying liquid nitrogen will be close to -196 C.

- Objects that are flexible at room temperature can become hard and brittle at liquid nitrogen and helium temperatures

https://www.youtube.com/watch?v=t28jBbOq0yg

Extreme cold - safety recommendations

- Avoid direct contact with cryogen and objects at cryogenic temperature, e.g. pipes carrying liquid nitrogen

- Wear eye protection when decanting liquid cryogens

- Wear insulated gloves

- Wear sensible shoes/boots (not sandals) with trousers covering the the top to ensure spilt liquids do not run inside

- Prevent spillage on plastic floor tiles and electric cables etc.

DON'T do this

The hazard of build up of high pressures

- 1 litre of liquid nitrogen (helium) expands to 0.7 (0.75) cubic metres of gas at room temperature

- Can cause build up of high pressure if gas is trapped, i.e. your piece of equipment becomes a bomb! unsecured bungs and stoppers become projectiles

https://www.youtube.com/watch?v=Jh5Y8Gb-kFU

High pressures – safety recommendations

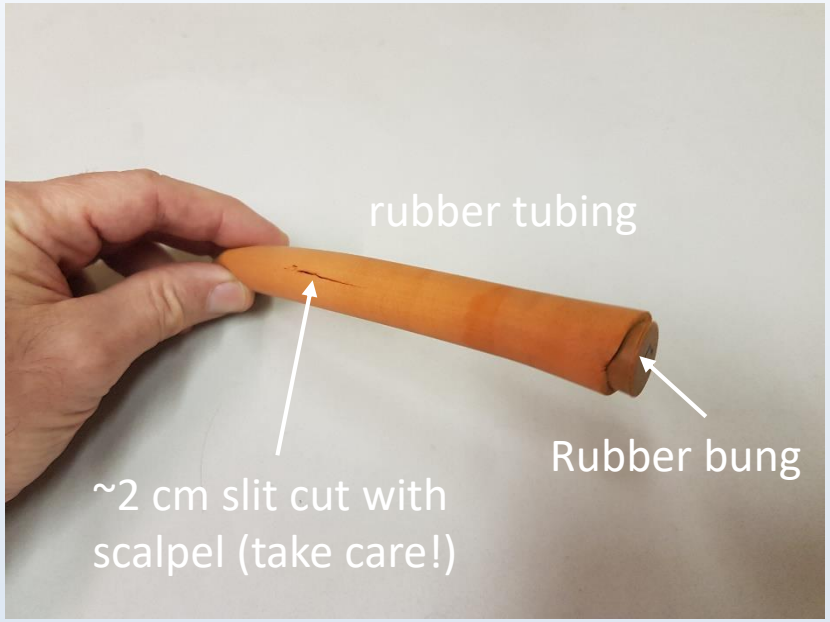
- Ensure all vents are clear and checked regularly for build up of ice
- Tie all stoppers to top of container with short length of string to act as a retainer if they pop out
- Fit non-return (one-way) and pressure relief valves

Modern containers are equipped with multiple safety pressure-release valves:

High pressures – safety recommendations

- "Home made" Bunsen (one way) valve

if your equipment has open vents like this



fitted on equipment

The hazard of oxygen depletion

• Nitrogen and helium gases in a closed space can displace/dilute oxygen in the air. Leading to risk of asphyxiation.

Normal fraction of air that is oxygen:	21%
Danger level:	<19%
Risk of permanent effects and death:	<14%

• Breathing pure nitrogen or helium gas can produce immediate loss of consciousness and lead to death.

Room volume m3	Volume of liquid nitrogen spilled, litres						
	1	2	3	4	5	10	25
10	19.6	18.1	16.7	15.3	13.8	6.7	
25	20.4	19.9	19.3	18.7	18.1	15.3	
50	20.7	20.4	20.1	19.9	19.6	18.1	
75	20.8	20.6	20.4	20.2	20.0	19.1	16.2
100	20.9	20.7	20.6	20.4	20.3	19.6	17.4

Oxygen depletion – safety recommendations

- NEVER accompany liquid cryogens in a lift.
- Use liquid cryogens in well ventilated spaces.
- If using large quantities, or you are unsure about the ventilation, fit oxygen depletion alarms set to sound at <19.5% oxygen in air.
- DO NOT enter an enclosed area where you expect there has been a significant release of a liquid cryogen.

hand-held oxygen depletion monitor

Fire hazard

• Liquid oxygen has a higher boiling point than liquid nitrogen and the liquid seen dripping form cold pipes carrying liquid nitrogen is mostly liquid oxygen.

Pure oxygen is a fire and explosion hazard

Safety Recommendations:

• Insulate pipes carrying liquid nitrogen.

• Do not allow the condensate to drip onto clothing or come into contact with grease/oil/flammable materials.

• keep away from naked flames and incandescent material.

Finally – Emergency Procedures

• **Cold burns** – treat as a normal burn, hold under tepid running water (not hot water!) for at least 15 minutes. If serious, like this one, seek medical assistance.

• **Spillage** – evacuate area in which spill has taken place, leaving doors/windows open for ventilation.

• **Container overpressure** – evacuate area and summon emergency services.

• **Asphyxiation** – seek immediate medical assistance.