University of Sussex

Safety Procedure and Guidance SPG-34-09 for the use of Gas cylinders, Compressed air and Cryogenic gases

1 GAS CYLINDERS

Legal Requirements

Pressure safety requirements are set down in the Pressure Systems Safety Regulations 2000. Detailed advice for implementing these regulations is given in the following publications:-

INDG-261 *Pressure systems- safety and you;* www.hse.gov.uk/pubns/indg261.pdf

Pressure Systems Safety Regulations, Approved Code of Practice, http://www.hse.gov.uk/pubns/priced/l122.pdf

BOC publication *Safe Under Pressure*, which gives detailed guidelines for the use of gases in cylinders, http://business.boc.com/online/Information/Data/Safe_under_pressure.pdf

Advice on interpretation of the above Codes of Practice and Guidance may be obtained from the University Safety Office.

Safety of Storage and Handling of Gas Cylinders

Comprehensive detailed safety advice is contained in the BOC Gases publication *Safe under pressure*.

Also see the BOC web site :- http://www.boc.ebcnet.co.uk/p/careWithCryogenics.pdf

When a cylinder becomes empty, the **cylinder valve MUST BE CLOSED** to prevent entry of moist air which would cause internal corrosion. Each standard cylinder weighs approximately 90 kg, so wear safety shoes with steel toe caps when handling them. Also wear **clean** gloves this allows you to "milk churn" cylinders along the floor from the secure store or use position to a trolley and not over great distances keeping them upright at all times. Never try to catch a falling cylinder. If a cylinder falls over, the main valve should only bend. If it did sheer off, the cylinder would only spin or move at 6 kph along the floor.

Acknowledgement: Written by M. Strong & T. Knapp incorporating extracts from other documents written by Peter Balance.
Reviewed by T Knapp/G Ward 2011

When transporting gas cylinders always remove the regulator and make sure the cylinder is placed in an upright cylinder trolley and is secure within the trolley, i.e. securing chains are tightly fastened or locking bar has wing nuts attached and screwed down, never bump down stairs. All trolleys used for transporting gas cylinders must have at least 3 wheels so they are stable and the user does not have to take the full weight of the cylinder. Cylinders may only be moved on a proper trolley, not with sack barrows, and the regulator valve must be taken off before they are moved.

Cylinders must be kept in a properly designed stand or chained to a bench in an upright position. The chain or strap must be tight enough so that the cylinder can not slide out if tipped. They must not be left free standing. When not in use the gas must be turned off at the cylinder valve, (do not remove the valve key from the cylinder). Where cylinders are issued with operating instructions, these must not be removed.

Spare cylinders must not be stored in the laboratory only those required for the purpose of the work should be in the laboratory or workshop.

Doors to the laboratory/workshop where gas cylinders are present must have a sign indicating that gas cylinders are present with an indication of the type of gas in use.

All areas where gas cylinders are in use must be suitably ventilated. Where there is a possibility of oxygen displacement and a risk of asphyxiation a low oxygen alarm must be installed, this should be determined by the risk assessment for the use of gas cylinders.

Cylinders should be stored in a well ventilated area or fireproof room external to the building. There must be a wall or partition giving at least a 3m vapour pathway between stored oxygen and fuel gas cylinders. This segregation applies to empty as well as full cylinders. (This separation does not apply to oxygen/acetylene cylinders **in pairs** which are **in use**.) Toxic and corrosive gases should be stored separately from all other gases. Containers should be clearly marked if empty or full.

The Main Hazards from Gas Cylinders

High Pressure - sudden explosive release of pressure or high pressure jet from small aperture.

Toxic gas - refer to COSHH assessment and data sheet.

Flammable or explosive gas.

Acknowledgement: Written by M. Strong & T. Knapp incorporating extracts from other documents written by Peter Balance.
Reviewed by T Knapp/G Ward 2011

Asphyxiation - when used in unventilated or confined spaces.

Manual handling - normal sized cylinders weigh in the order of 90Kg.

There are three main types of gases:

- inert gases e.g. nitrogen, carbon dioxide	- these are not life supporting. Entry into a confined space where the inert gas has significantly reduced the oxygen concentration can cause rapid loss of consciousness and unless affected persons are rescued death may occur.
- fuel gases e.g. acetylene, hydrogen, propane	- these are highly flammable and explosive in air, even in low concentrations, if a source of ignition is present. - these are also not life supporting. Entry into a confined space where the gas has significantly reduced the oxygen

Acknowledgement: Written by M. Strong & T. Knapp incorporating extracts from other documents written by Peter Balance.
Reviewed by T Knapp/G Ward 2011

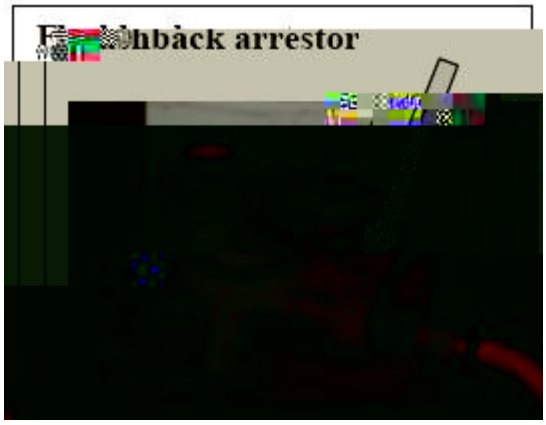
http://www.boconline.co.uk/health/gas_safety/identifying_gas_cylinders/industrial_cylinder_colours.asp

Do NOT rely on colour coding as an indicator of cylinder contents this must be used in conjunction with the cylinder contents label. If no label is present do not accept the cylinder.

Regulators

Acknowledgement: Written by M. Strong & T. Knapp incorporating extracts from other documents written by Peter Balance.
Reviewed by T Knapp/G Ward 2011

have flashback arrestors and hose check valves should be fitted next to the torch where the gases are mixed prior to combustion.



Dealing with a flashback incident - Failure to use the correct nozzle size or, more often, failure to set the correct gas pressure can result in a flashback or 'backfire' which, if no flashback arrestor is fitted, could travel into the cylinder where it may cause internal heating or even explosive decomposition of the acetylene! To deal with a flashback:

(a) close blowpipe/torch valves (oxygen first), then
(b) close both cylinder valves;
(c) check surface of acetylene cylinder with bare hand for local heating;
(d) if heating is detected, treat as though cylinder has been in a fire; activate the nearest break-glass call point, evacuate the area to 200 m. and call the emergency number 3333 notifying Security of the incident and request immediate attendance of the Fire and Rescue Service.
(e) if temperature does not rise, unwind pressure adjustment screws on both regulators;
(f) check nozzle of torch - if hot, plunge it into hot water to cool it;
(g) check that nozzle is undamaged.
(h) take flashback arrestors and regulators off and examine them for burns. If necessary replace them;
(i) carry out lighting procedure as recommended by supplier. If flashback occurs again, go through above safety procedure and, if necessary, replace torch and nozzle.

Hoses

Hoses must be of the correct thickness to withstand the required operating pressures. They must also be in good condition, and kept clear of possible damage by cuts, cracks and burns, and contact with oils, solvents, grease, etc. Blue hose must be used for oxygen and red for acetyf(y)20(ge)4(n)-9( )-49(a)4(n

Acknowledgement: Written by M. Strong & T. Knapp incorporating extracts from other documents written by Peter Balance.
Reviewed by T Knapp/G Ward 2011

Keep hose lengths as short as possible. If the cylinder cannot be positioned near to the delivery point then the gas should be piped in compatible metal tubing to a suitable take-off point..

Special precautions for commonly used gases.

Note that with the exception of oxygen and air there is a risk of asphyxiation with all compressed gases should cylinders leak or otherwise discharge into poorly ventilated areas.

Hydrogen.

Flammability

Acknowledgement: Written by M. Strong & T. Knapp incorporating extracts from other documents written by Peter Balance.
Reviewed by T Knapp/G Ward 2011

position. It is also unsafe to use acetylene at a rate exceeding 20% of the cylinder contents each hour or acetone may boil off, thereby reducing the stability of the cylinder contents. To minimise the risk of flashback to the cylinder ALWAYS ensure an adequate flow of fuel gas is issuing from the blowpipe nozzle before lighting the gas.

Acetylene must not be delivered at a pressure greater than 0.6 bar (9 psi)

In the case of all combined acetylene and oxygen apparatus, **flashback arrestors** must be fitted to

Acknowledgement: Written by M. Strong & T. Knapp incorporating extracts from other documents written by Peter Balance.
Reviewed by T Knapp/G Ward 2011

For remote work, take a small, e.g. 'Midipak' or 'Startapak', welding unit to the work location.

Sources of Heat or Ignition

DO NOT SMOKE, near cylinders or allow cylinders to come into contact with any **EXPOSED FLAME, ELECTRICAL APPARATUS OR LIVE WIRES**. Keep well clear of welding or cutting operations.

2 COMPRESSED AIR

Some labs and workshops are supplied with compressed air from a building local compressor these are normally in the order of 80-100psi.

Jets of compressed air are highly dangerous and should NEVER be pointed at other people (or oneself). Compressed air can cause skin damage.

Compressed air hose must be kept in good condition and anchored so that it cannot thrash around in the event of a breakage.

Compressed air should not be used to clean down machine tools or to remove grit or swarf. A vacuum cleaner or a brush are safer and avoid spreading foreign matter over surrounding equipment.

3 CRYOGENIC LIQUID & SOLID GASES

The most common in use at the university are liquid Helium (-269^{o} C), liquid nitrogen (-196^{o}C) and solid CO2 (-78^{o}C).

Hazards

Cold liquefied gases and solid carbon dioxide present a number of hazards.
Severe cold burns (frostbite) can result from mishandling, especially if the liquid is trapped in shoes or clothing. Brief exposure to extremely cold air produces some discomfort in breathing, longer term exposure can cause lung damage.

The evaporation of large quantities of liquid nitrogen/helium or the sublimation of large quantities of carbon dioxide in confined areas may result in displacement of oxygen and the risk of asphyxiation.

The cooling effect can cause structural damage. Structural steel may result in brittle fracture.
Spillage of liquid nitrogen may cause cracking in plastic insulation on electrical leads.

Because oxygen freezes at -183^{o}C oxygen from the air can condense on material cooled to liquid N or Liquid He temperatures this could pose a risk of combustion if this condensed liquid Oxygen comes into contact flammable material such as cloth or oil.

Precautions.

Acknowledgement: Written by M. Strong & T. Knapp incorporating extracts from other documents written by Peter Balance.
Reviewed by T Knapp/G Ward 2011

Special techniques are needed to handle liquid hydrogen and helium. Instruction from a competent person must be received before attempting procedures for the first time.

The rules for filling dewars with liquefied nitrogen are on a notice at

Acknowledgement: Written by M. Strong & T. Knapp incorporating extracts from other documents written by Peter Balance.
Reviewed by T Knapp/G Ward 2011

floor you are dispatching the dewar from and one at the receiving floor. It maybe advisable to have a notice on the dewar to warn others not to enter the lift .

Wherever liquid or solid gases are used the area must be well ventilated or sufficiently large, to ensure that the oxygen concentration does not fall below 19.5% vol. Oxygen depletion monitors MUST be installed in areas where a number of dewers are located or where they are located in small spaces. **Because they are tightly sealed, cold rooms are particularly unsuitable as storage areas for liquid nitrogen and they must not be used for this purpose**.
Please contact the University Safety Office for further guidance.

Where pipework carrying cryogenic gases are installed it MUST be appropriately insulated and warning tape attached along the length. Where liquid nitrogen take-off points from a bulk supply tank are provided inside a building, whether for manual operation or for automatic filling of storage tanks, then oxygen monitoring must be provided at those points

Cryogenic Gas containers

(a) Liquefied gas containers must be handled carefully at all times.
(b) They must be protected from the weather, i.e. not left out of doors or in conditions favourable to the formation of an ice plug in the neck.
(c) Ice plugs can cause a 300 psig pressure build-up and an explosion. Such obstruction of the neck should be cleared with clean metal rods by an operator standing as far away as is practicable.
(d) Wide mouthed vessels should be used and when dewars are being purchased wide mouthed, all welded vessels with bursting discs must be chosen.
(e) Tight fitting stoppers or bungs must not be used on dewars or flasks containing liquid gases.
(f) Only use sample storage vials designed for use with liquid nitrogen. Vapour phase storage is recommended as the shrinkage and embrittlement of materials renders any sealing system ineffective and the relatively low surface tension of liquid nitrogen also makes it likely to seep into the vial leading to a potential explosion

First aid for cold burns

Do not remove clothing or material adherent (stuck) to person until thawed so it can be removed easily.
Skin; thaw slowly in lukewarm water approx 40-45

Acknowledgement: Written by M. Strong & T. Knapp incorporating extracts from other documents written by Peter Balance.
Reviewed by T Knapp/G Ward 2011