

# Guidelines for gas cylinder safety

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BOC is committed to practising and communicating safe operations around the world as part of its commitment to robust product stewardship. It is as important for BOC to impart safe working methodologies to customers and suppliers as it is to have clear, established and measurable performance standards practised by all BOC plants, depots and distributors – regardless of plant, product or service.

BOC has:

- Safety as its highest priority.
- One simple goal: zero incidents and injuries.
- Well-established programmes to drive improvement in SHEQ (Safety, Health, Environment, Quality) performance.



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# Introduction

Many people in industry, schools, laboratories and maintenance use gases from compressed gas cylinders. The gas contained in these cylinders is under very high pressure. Over the past decade, developments in cylinder technology have enabled cylinder pressure to be significantly increased.

To maintain and continue to improve the current safety record for the use of these cylinders, increased knowledge and understanding of the DO's and DON'Ts is essential.

For new users of gas cylinders, it is essential that they receive adequate training and guidance prior to use.

These guidelines distill the experience and knowledge of various competent individuals in an effort to provide guidance for safer handling of gas cylinders.

They focus on a number of known issues and on situations where the same or similar incidents have reoccurred.

Every possible issue or occurrence can neither be anticipated nor covered.

If in doubt, call the **BOC Emergency Response line on 1800 653 572** in situations or occurrences that fall outside guidelines.

It is recommended this document be kept for handy reference by every:

- Manager
- Engineer
- Foreman
- Tradeperson
- Storeperson
- Operator

## Scope of these guidelines

These guidelines cover compressed and liquefiable gas cylinders as shown on the Gas Cylinder Identification Chart on pages 8-9.

Please note that the identification of the gas contents of any cylinder is given by the label on the cylinder and is qualified by the colour(s) of the cylinder, and the cylinder valve outlet.

These guidelines touch on toxic gases (e.g. Ammonia which is used as a refrigerant) but does not cover these gases in detail as these are considered generally the domain of "Special gases" mentioned below.

## Medical gases

Information on "Medical gases" sold by BOC is available from BOC branches or by calling Customer Service on 131 262 (for Oxycare customer service call 1800 050 999).

## Special gases

A full range of "Special gases" is also obtainable from BOC. Information on their properties and safe handling is given in the *Scientific Gases and Equipment Manual* and *Material Safety Data Sheets (MSDS)*.

## Cryogenic liquids

Information on "Cryogenic liquids" sold by BOC is available through customer service on 1300 363 109.

## Legislation and standards

This gas cylinder information booklet is intended as a guide and the reader should supplement this gas cylinder information with legislation regulation, codes of practice and Australian Standards applicable to their specific operating needs.

## Refrigerant gases

In Australia, environmental issues relevant to all refrigerant Fluorocarbon gases are covered by environmental regulation. The Montreal Protocol (1987) covers issues of ozone depletion and leads the phase-out of Chlorofluorocarbons (CFCs) by 1996 and Hydrofluorocarbons (HFCs) by 2015. Greenhouse gas emissions and global warming issues are controlled by the Kyoto Protocol of 1997. HFCs are among the six listed gases in the Kyoto Protocol. Under those environmental concerns and regulations natural refrigerants such as carbon dioxide and ammonia are becoming the new environmentally friendly refrigerants. BOC supplies the full range of refrigerant gases and is committed to controlling environmental impact. Information on refrigerant gases is available through our customer service refrigeration hotline on 1300 133 286.

**BOC is committed to promoting the safe handling of gases wherever possible and hopes that this document will serve as an educational tool outlining the potential hazards of working with gases as well as promoting safer practices around their use, handling and transport.**



# Know your gases

## Associated risks and hazards of handling gases

Since gases are invisible their presence is not readily identifiable and they have the potential to asphyxiate, burn or harm users.

Each year in Australia, there are incidents which involve the use of compressed or liquefied gases.

Many of these could have been avoided if the user had followed information contained in the Material Safety Data Sheet (MSDS) or had referenced this document or other similar freely available information.

### Label

The label is the primary means of identification of the cylinder contents (see next page).

If the label is illegible or missing, DO NOT use the cylinder but return it to the gas company for a satisfactory replacement.

### Cylinder colour

Cylinder colour is the secondary means of identification of the nature of the cylinder contents and the nature of the hazard associated with the gas contained in the cylinder.

### Additional information

In the interests of personal safety, customers MUST familiarise themselves with:

- The respective MSDS
- Gas equipment operation and manual

Copies of current MSDSs for each of the gases stored and used must be collated and kept in a convenient location for quick reference in relation to:

- Storage
- Handling
- Transport issues
- Personal Protective Equipment
- Incident response

**For MSDSs please visit [www.boc.com.au](http://www.boc.com.au) or contact 131 262.**

## Main gases hazard classifications. Special precautions when handling.

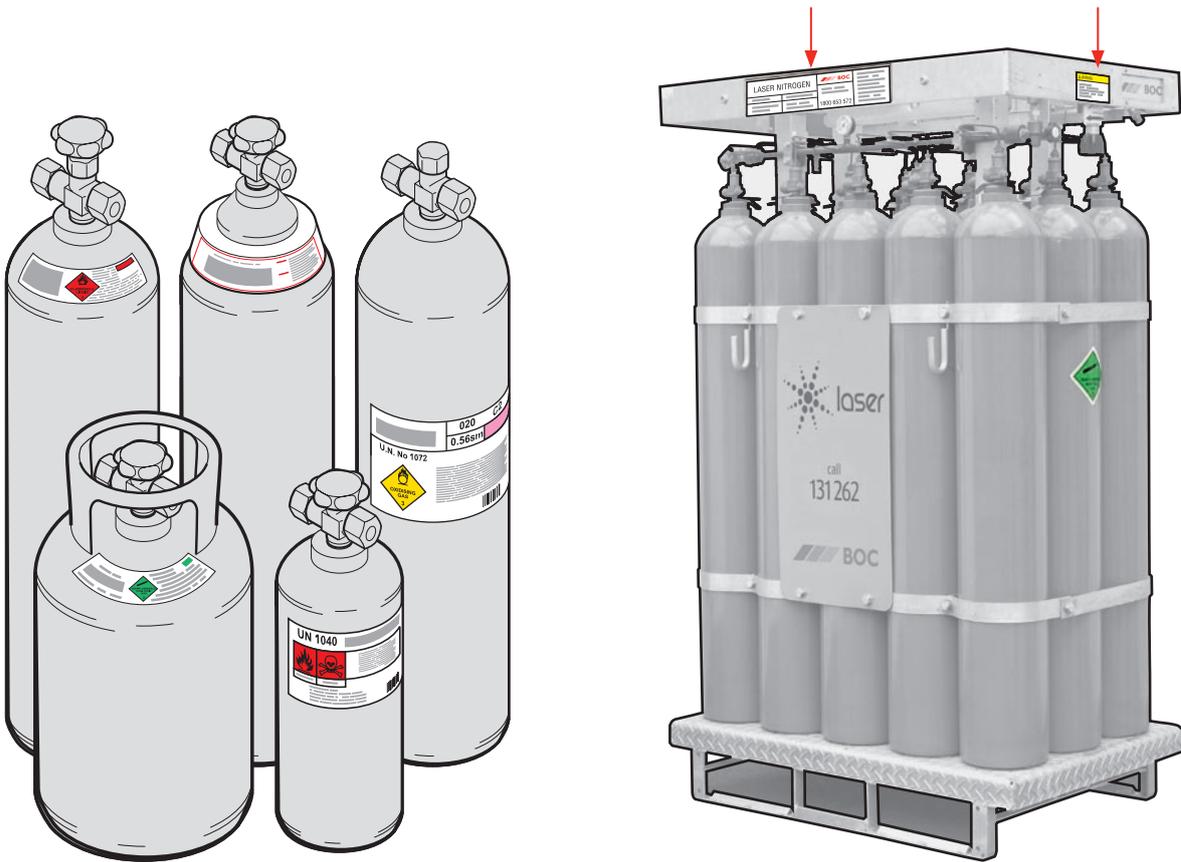
Class Diamonds	Australian Standards Definition	Cylinder Colour Identification*
 Toxic	A gas that is known to be a) toxic or corrosive to humans as to pose a hazard to health; or b) presumed to be toxic or corrosive to humans because it has an LC 50 value equal to or less than 5000 ml/m <sup>3</sup> (ppm).	Hues of Yellow
 Flammable	A gas which will burn in air at a pressure of 101.3 kPa absolute.	Hues of Red
 Oxidising	A gas which gives up oxygen readily, removes hydrogen from a compound, or readily accepts electrons.	Hues of Black, White, or bright Blue
 Non-flammable, non-toxic	A gas which is non-flammable, non-toxic, non-oxidising, and is resistant to chemical action under normally encountered conditions.	Hues of Brown, Green or dark Blue

\*For non imported gases

## BOC cylinder and pack identification label

1	Gas name and grade
2	United Nations numbering system for safe handling, transport and storage
3	Dangerous Goods Classification
4	BOC gas code and cylinder size
5	Contents of cylinder at standard temperature and pressure i.e. (15°C @ 101.3kPa)
6	Nominal filling pressure at standard conditions (for permanent gas)
7	Caution – indicated major hazards*
8	General safety information*

\*Always refer to Material Safety Data Sheet (MSDS)



Labels vary in shape, size and their positioning on cylinders and packs (indicated by red arrows).

# Guidelines for Gas Cylinder Safety

Primary hazards for commonly used industrial gases are given below:

Major Hazard	Gas	Cylinder Colour	Characteristics
Asphyxiant	Carbon Dioxide	Green Grey AS No. N32 	<ul style="list-style-type: none"> <li>Can cause the nose to sting.</li> <li>Will collect in ducts, drains and low lying areas. e.g. cellars.</li> <li>At high concentrations, instant unconsciousness may occur followed by death.</li> <li>Much heavier than air.</li> </ul>
Asphyxiant	Nitrogen	Pewter AS No. N63 	<ul style="list-style-type: none"> <li>Odourless.</li> <li>No warning signs before unconsciousness occurs.</li> <li>At high concentrations almost instant unconsciousness may occur, followed by death.</li> <li>Heavier than air.</li> <li>Does not burn.</li> <li>Largely Inert.</li> </ul>
Asphyxiant	Argon	Peacock Blue AS No. T53 	<ul style="list-style-type: none"> <li>Odourless.</li> <li>No warning signs before unconsciousness occurs.</li> <li>At high concentrations almost instant unconsciousness may occur, followed by death.</li> <li>Heavier than air.</li> <li>Does not burn.</li> <li>Inert.</li> </ul>
Asphyxiant	Helium Balloon Gas	Brown AS No. X54 	<ul style="list-style-type: none"> <li>Inert but asphyxiant at high concentrations – lighter than air.</li> <li>DO NOT INHALE UNDER ANY CIRCUMSTANCES.</li> </ul>
Flammable Extremely hazardous	LPG	Silver, grey or galvanised 	<ul style="list-style-type: none"> <li>LPG is 'stenched' (odourised) and has a distinctive odour.</li> <li>It will ignite and burn instantly from a spark or piece of hot metal.</li> <li>Is heavier than air and will collect in ducts, drains etc., and low lying areas.</li> <li>Fire and explosion hazard.</li> <li>Highly flammable.</li> <li>Eliminate all ignition sources.</li> </ul>
Flammable Extremely hazardous	Acetylene	Claret AS No. R55 	<ul style="list-style-type: none"> <li>Distinctive garlic smell.</li> <li>Fire and explosion hazards are greater than LPG but it is slightly lighter than air and less likely to collect in ducts and drains.</li> <li>Requires minimal energy to ignite in air or oxygen.</li> <li>Do not use with copper, high copper or brass alloys because copper materials form explosive compounds with Acetylene.</li> </ul>
Flammable Extremely hazardous	Hydrogen	Signal Red AS No. R13 	<ul style="list-style-type: none"> <li>Odourless.</li> <li>Much lighter than air.</li> <li>Will collect at the highest point in any enclosed space unless ventilated at high level. Invisible flame.</li> <li>Fire and explosion hazard.</li> <li>Very low ignition energy.</li> <li>Burns with an invisible flame.</li> </ul>
Oxidising Strongly supports and accelerates a flame or fire.	Oxygen	Black AS No. N61 	<ul style="list-style-type: none"> <li>Odourless.</li> <li>Generally considered non-toxic at atmospheric pressure.</li> <li>Will not burn, but supports and accelerates combustion.</li> <li>Materials not normally considered combustible may be ignited by sparks in oxygen rich atmospheres.</li> <li>No oil, grease or lubricants should come into contact with oxygen.</li> </ul>

Illustrations above are intended to be typical only showing colour and label location. They neither reflect the size or shape of cylinders, nor show the cylinder valve or guard (where fitted).

This lists identifies primary hazards only. Other hazards may apply.

# BOC industrial and refrigeration gas cylinder colour identification

Air Based Gases			Fabrication Gases	
<b>Air</b> ♦ Industrial Grade <b>052</b>  Band: Black Body: Pewter	<b>Nitrogen</b> ♦ Industrial Grade <b>032</b>  Body: Pewter	<b>Oxygen</b> ♦ Industrial Grade <b>020</b>  Body: Black	<b>Argon</b> ♦ Welding Grade <b>061</b>  Body: Peacock Blue	<b>Carbon Dioxide</b> ♦ Industrial Grade <b>081</b>  Body: Green Grey
Shielding Gases				
<b>Argoshield</b> ® ♦ Light <b>060</b> Universal <b>065</b> Heavy <b>064</b>  Bands: Black, Green Grey Body: Peacock Blue	<b>Argoshield</b> ® ♦ <b>40 068</b>  Band: Black Body: Peacock Blue	<b>Argoshield</b> ® ♦ <b>52 070</b>  Band: Green Grey Body: Peacock Blue	<b>Argoshield</b> ® ♦ <b>54 071</b>  Bands: Black, Green Grey Body: Peacock Blue	<b>Argoshield</b> ® ♦ <b>100 095</b>  Bands: Green Grey, Brown Body: Peacock Blue
<b>Stainshield</b> ® ♦ <b>075</b>  Band: Black Body: Peacock Blue	<b>Stainshield</b> ® ♦ Heavy <b>092</b>  Bands: Green Grey, Brown Body: Peacock Blue	<b>Stainshield</b> ® ♦ <b>66 093</b>  Bands: Signal Red, Green Grey Body: Peacock Blue	<b>Stainshield</b> ® ♦ <b>69 094</b>  Bands: Black, Brown Body: Peacock Blue	
<b>Alushield</b> ® ♦ Light <b>079</b>  Band: Brown Body: Peacock Blue	<b>Alushield</b> ® ♦ Heavy <b>069</b>  Band: Peacock Blue Body: Brown	<b>Argoplas</b> ® ♦ <b>5 143</b> <b>20 144</b> <b>35 145</b>  Band: Signal Red Body: Peacock Blue	<b>Specshield</b> ® ♦ Copper <b>077</b>  Band: Black Body: Peacock Blue	
Fuel Gases				
<b>Acetylene</b> ♦ Industrial Grade <b>040</b>  Body: Claret	<b>Handigas™ LPG</b> ♦ Industrial Grade <b>112</b>  Body: Silver Grey or Galvanised	<b>Handigas™ LPG</b> ♦ Gas withdrawal <b>110</b>  Body: Silver Grey or Galvanised	<b>Handigas™ LPG</b> ♦ Liquid withdrawal <b>110</b>  Top: Royal Blue Body: Silver Grey or Galvanised	<b>Hydrogen</b> ♦ Industrial Grade <b>135</b>  Body: Signal Red

## BOC industrial and refrigeration gas cylinder colour identification (cont)

Laser Gases				
<p><b>Carbon Dioxide</b> ♦ Laser Grade 131</p>  <p>Body: Green Grey</p>	<p><b>Oxygen</b> ♦ Laser Grade 128</p>  <p>Body: Black</p>	<p><b>Helium</b> ♦ High Purity 120</p>  <p>Body: Brown</p>	<p><b>Nitrogen</b> ♦ Laser Grade 129 Available in packs only</p>  <p>Body: Pewter</p>	<p><b>Nitrogen</b> ♦ High Purity 234</p>  <p>Body: Pewter</p>
Refrigeration Gases				
<p><b>Refrigerant</b> ♦ R134a 155</p>  <p>Band: Aqua Body: Galvanised or White</p>	<p><b>Refrigerant</b> ♦ R22 158</p>  <p>Band: Moss Green Body: Galvanised or White</p>	<p><b>Refrigerant</b> ♦ R404A 248 Eductor tube Fitted</p>  <p>Band: Brown Body: Galvanised or White</p>	<p><b>Refrigerant</b> ♦ R407C 244 Eductor tube Fitted</p>  <p>Band: Brown Body: Galvanised or White</p>	<p><b>Refrigerant</b> ♦ R408A 245 Eductor tube Fitted</p>  <p>Band: Brown Body: Galvanised or White</p>
<p><b>Refrigerant</b> ♦ R409A 246 Eductor tube Fitted</p>  <p>Band: Brown Body: Galvanised or White</p>	<p><b>Refrigerant</b> ♦ R410A 168 Eductor tube Fitted</p>  <p>Band: Brown Body: Galvanised or White</p>	<p><b>FR12™</b> ♦ Refrigerant R416A 249 Eductor tube Fitted</p>  <p>Band: Brown Body: Galvanised or White</p>	<p><b>Refrigerant</b> ♦ R507 250</p>  <p>Band: Brown Body: Galvanised or White</p>	<p><b>Ammonia</b> ♦ Refrigerant R717 178</p>  <p>Band: Slate Body: Galvanised or White</p>
Class Diamonds				
<p>The gas contents of BOC cylinders are identified by the labels affixed to the cylinders. A cylinder without a label MUST NOT be used, but is to be returned to the supplier. An important part of the label is the class diamond, which represents the characteristic of the gas (as illustrated adjacent). A label with multiple class diamonds indicates multiple associated hazards.</p>	<p><b>Oxidising Gas</b> Class 2.2 / 5.1</p>  <p>Diamond: Yellow Lettering: Black</p>	<p><b>Flammable Gas</b> Class 2.1</p>  <p>Diamond: Red Lettering: Black or White</p>	<p><b>Toxic Gas</b> Class 2.3</p>  <p>Diamond: White Lettering: Black</p>	<p><b>Non-Flammable, Non-Toxic Gas</b> Class 2.2</p>  <p>Diamond: Green Lettering: Black</p>
	<p><b>General definitions</b></p>			
<p><b>Oxidising</b> Many materials which will not burn in air may readily ignite and or burn in the presence of an oxidising gas – e.g. oxygen. This includes work clothing and many materials considered non flammable.</p>	<p><b>Flammable Gas</b> Flammable gas in the presence of the correct mix of air and an ignition source will lead to combustion.</p>	<p><b>Toxic Gas</b> A gas that is known to be so toxic or corrosive to humans as to pose a hazard to health.</p>	<p><b>Non-flammable, Non-toxic</b> A gas which is non-flammable, non-toxic, non-oxidising, and is resistant to chemical action under normally encountered conditions. The displacement of oxygen or air by an inert gas may pose a risk of asphyxiation.</p>	

### Notes

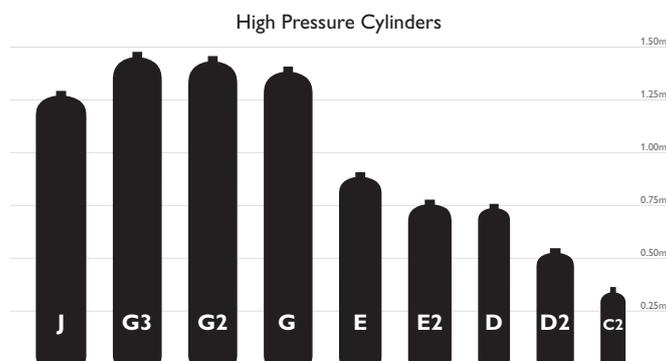
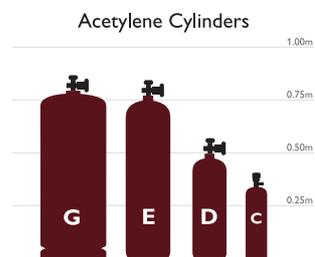
1. Colour names and reference numbers refer to AS 2700
2. Designated cylinder colours comply with AS 4484:2004
3. Numbers in Red are BOC's Gas Code
4. Cylinder valves not shown
5. Refer to Australian Standard definitions

# About your cylinders and valves

## Design and construction of gas cylinders

BOC gas cylinders are designed and constructed in accordance with Australian and International Standards as applicable. These Standards define, the cylinder's:

- Material
- Method of manufacture
- Test pressure
- Maximum permissible filled pressure and
- Method of periodic inspection



## Compressed gas cylinder sizes

### Single cylinders

BOC offers a wide range of single high pressure cylinders suitable for small volumes of gas, available in many sizes and pressures.

BOC cylinder sizes are denoted by a letter code. The gas content of cylinders is measured in cubic metres, litres or kilograms. If volume unit is given, it refers to standard temperature and pressure of 15°C (101.3 kPa).

Cylinder sizes, capacities and physical dimensions are shown below and on the following pages. Not all products are available in all sizes listed, please consult BOC 131 262 for details.

### Manifolded Cylinder Pack (Pack or Bundle)

Cylinders are normally used individually or collectively. A Manifolded Cylinder Pack (see pic on next page) describes cylinders used collectively, interconnected by a manifold – a portable frame. These are often bundled in packs of 4, 9 or 15 cylinders. Collective use of cylinders is necessary for customers who require larger quantities of gas.

Where customers do not have adequate handling facilities for on and off loading from the delivery vehicle, BOC can deliver on vehicles with suitable manual handling equipment.

### **NEVER** remove individual cylinders from Manifolded Cylinder Packs.

These are designed and supplied as integral units with gas content labels to suit. Removal of individual cylinders renders the label contents incorrect and may have safety implications.





**300 bar Manifolded Cylinder Pack**

- |   |                                       |
|---|---------------------------------------|
| 1 | Contents Pressure Indicator (300 bar) |
| 2 | Outlet Pressure Gauge (0-60 bar)      |

## Maintenance and testing of gas cylinders

In most cases BOC is the owner of the cylinder. As the owner, BOC is responsible for complying with the statutory requirements relating to maintenance and periodic testing of cylinders.

Australian Standard AS 2030 details the statutory requirements in respect to design, manufacture, inspection and filling.

## Cylinder contents identification

All BOC cylinders are labelled in accordance with the requirements of the Australian Dangerous Goods Code (ADG Code) for transport of dangerous goods by road and rail.

Cylinder labels identify the gas contents of the cylinder and provide basic safety information (see page 6).

**NEVER use any cylinder or pack unless it is clearly labelled and can be positively identified.**

## Typical permanent identification marks on cylinders

For seamless cylinders, permanent identification markings are usually found on the shoulder or base of the cylinders. For fabricated cylinders, markings are found on the valve protection ring (VPR).

**NEVER change a cylinder's contents from what was otherwise intended**

**NEVER repaint a cylinder**

**NEVER change a cylinder's markings or identification**

**It is dangerous to change the contents or external colour of a cylinder**



Markings on Permanent Gas cylinder

- Owner Stamp Mark
- Weight
- Serial No.
- Test pressure of shell
- Manufacturer's stamp
- Test date (retest date)
- Specification
- Charging pressure
- Water capacity
- Gas traffic



Markings on Acetylene cylinders

- Owner Stamp Mark
- Weight empty with mass embossed by BOC
- Serial No.
- Test pressure of shell
- Manufacturer's stamp
- Test date (retest date)
- Porous mass manufacturer/type
- BOC – Inspector's approval stamp
- Water capacity



Markings on Fabricated cylinders

- Owner Stamp Mark
- Empty weight & Tare weight
- Serial No.
- Test pressure of shell
- Manufacturer's stamp
- Test date (retest date)
- Specification
- Water capacity

# + Guidelines for Gas Cylinder Safety

## Cylinder valves

All BOC cylinders containing gas under pressure are fitted with a cylinder valve which **MUST NOT** be removed or tampered with at any time as this will compromise the safety of the cylinder.

Removing fittings under pressure may result in serious personal injury as fittings may be projected at high velocity.

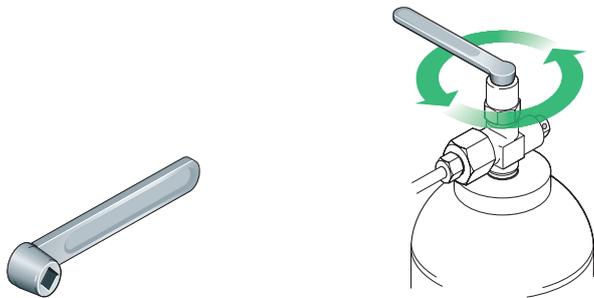
Each valve outlet is specially threaded to receive commercially available pressure regulators. They can be obtained from BOC Gas & Gear centres and agents. Regulators are first screwed in fully to the cylinder valve outlet by hand and then tightened using the regulator spanner.



- |   |                             |
|---|-----------------------------|
| 1 | Regulator Outlet Connection |
| 2 | Cylinder Valve              |
| 3 | Regulator Spanner           |

In the case of a key operated cylinder valve, turn the rectangular key **ANTICLOCKWISE** using the cylinder valve key (see below). Cylinder valve keys are available from BOC Gas & Gear centres (Part No. 309275).

Most cylinders are fitted with handwheels. This avoids the need to use a cylinder valve key.



Cylinder valve key

Turn anticlockwise to open key operative valve

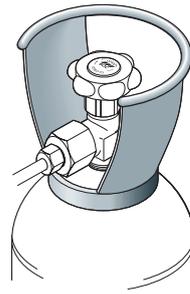
## Valve guards and valve protection caps

Some cylinders are fitted with valve guards or valve protection caps.

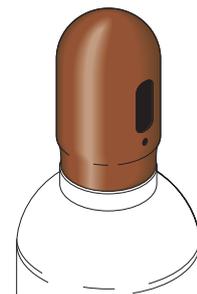
**DO NOT** remove valve guards.

**DO** replace valve protection caps whenever the cylinder is not secured or not in use.

**DO** return your cylinder to BOC with the valve in the closed position and with the protection cap on (refer to "Opening or Closing cylinder valves" on next page)



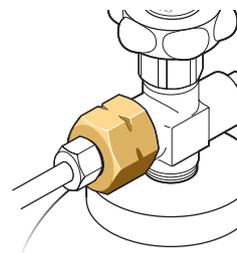
Valve Guard



Valve Protection Cap

## Valve outlets threaded

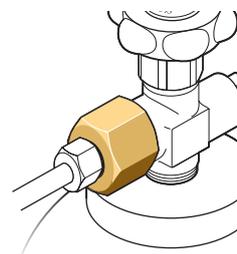
For safety reasons, flammable gases and non-flammable gases have their cylinder valve outlets threaded opposite hand. This prevents the connection of the incorrect regulator to cylinder valve outlets.



Left-hand thread – Notched

**Valve outlets for flammable gases are screwed LEFT-HAND (anticlockwise to tighten).** Identifiable by its notched appearance.

Cylinders containing flammable gases like acetylene, hydrogen, propane and mixtures containing fuel gas all have left-hand threads.



Right-hand thread – Plain

**Valve outlets for non-flammable gases are screwed RIGHT-HAND (clockwise to tighten).**

Cylinders containing non-flammable/non-toxic gases all have conventional right-hand threads. Non-flammable gases can be oxidising e.g. oxygen; or non-flammable, non-toxic e.g. nitrogen, argon and air.

The only exception to this rule are cylinders used on forklift trucks. These cylinders have **RIGHT-HAND** thread valve outlets.

As an additional safety precaution, in 2006 air and nitrogen cylinder valve outlet sizes and threads were differentiated from oxygen to prevent the:

- incorrect connection of an oxygen cylinder to applications where an inert gas is required
- incorrect connection of an oxygen cylinder to applications where only air (21%) oxygen is required.

**DO NOT** damage the threaded portions by connecting an incorrect regulator

**DO NOT** over-tighten or use excessive force to connect equipment

**DO** call BOC for a replacement cylinder if the regulator does not connect properly

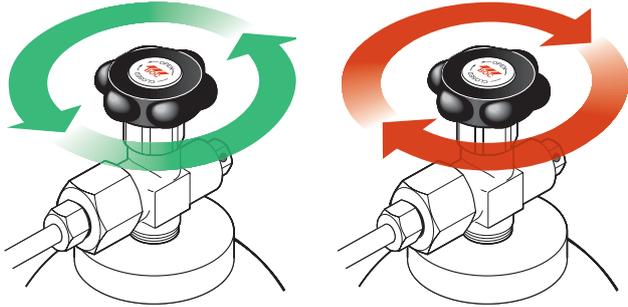
## Before operating a cylinder valve

### OPENING or CLOSING cylinder valves

OPEN by turning the handwheel or cylinder valve key anti-clockwise. Only use reasonable force.

CLOSE by turning the handwheel or cylinder valve key clockwise. Only use reasonable force.

When in use, cylinder valves used in the fully open position may become stuck in this open position. To prevent this ensure that the handwheel or cylinder valve key is turned back half a turn.



Open

Close

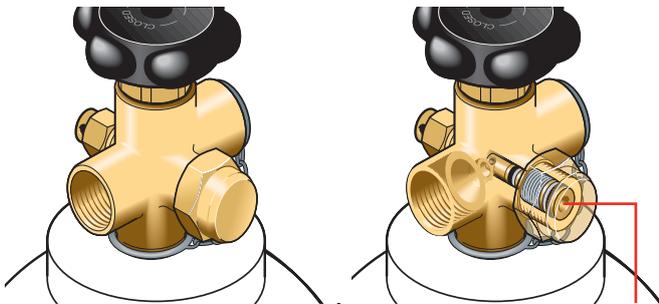
### Cylinder valves with an integrated regulator (applicable currently to 300 bar filled cylinders and MCPs e.g. nitrogen, shielding gases)

BOC cylinders are filled to a variety of pressures e.g. sub 200 bar – 137, 163, 175 and 200 bar. The largest capacity cylinders are filled to 300 bar to allow more gas to be filled at a higher pressure in an equivalent sized cylinder. Controlling the pressure within these 300 bar cylinders to operating level (i.e. 200 bar or less) is a tiny integral pressure regulator. The cylinder valve complete with this regulator is known as a Valve Integrated Pressure Regulator (VIPR).

BOC's 300 bar cylinder valves come fitted with VIPRs. This VIPR is typically set to a maximum output of 60-80 bar pressure at any given time. Therefore an existing regulator of 200 bar or less can be used with these 300 bar cylinders.

As a result of the VIPR, when a 200 bar regulator is fitted, the gauge on this 200 bar regulator will only display a 60/80 bar inlet pressure even though the cylinder has actually been filled to 300 bar.

The only exception to this are the Laser MCPs which come fitted with a high flow rate 300 bar regulator. This regulates the outlet of the cylinder MCP to the selected outlet pressure which is adjustable from 0 to 35 bar.



300 bar filled cylinder fitted with a cylinder valve featuring an integrated regulator

Cross section view displaying the tiny integrated regulator on the right side

### Handy hints for identifying the cylinder contents pressure

- **300 bar MCPs** have a centrally mounted pressure gauge which indicates the MCP's contents pressure (approx. 300 bar when full)
- **For J cylinders** the contents label indicates the pressure when full
- **For cylinders filled to 200 bar or less**, the contents label initially indicates the cylinder contents pressure when full. Thereafter, as gas is consumed, the regulator inlet pressure gauge will show the cylinder contents pressure.

To convert from MPa/kPa/psi to bar refer to the pressure cross reference chart in the glossary. Alternatively contact BOC 131 262.

Note: Gauges are to be used for indication purposes only.

### Pressure relief devices

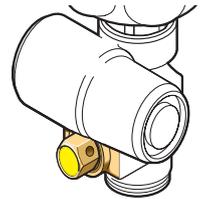
Most cylinders or manifolded cylinder packs are fitted with a relief device. In a situation where excess pressure is encountered, this is designed to discharge cylinder contents either completely or only discharge the excess pressure. This is accompanied by a high pitched noise. There are three types of commonly used pressure relief devices:

- burst disc (most common)
- fusible plug (e.g. acetylene)
- pressure relief valve (e.g. LPG)

#### Burst disc

In the event of overpressure, this is designed to burst, leaving an open passage for gas contents to escape completely.

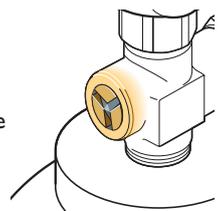
e.g. Carbon Dioxide (CO<sub>2</sub>) cylinders are fitted with a burst disc which operates at approximately 207 bar and is fitted on the cylinder valve.



#### Fusible plug

This plug is designed to melt, releasing contents completely.

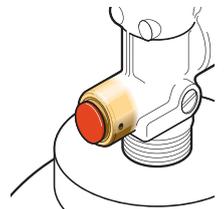
e.g. Acetylene cylinders are fitted with fusible plugs which melt at approximately 100°C.



#### Pressure relief valves

This valve is designed to relieve excess pressure and close again after relieving the excess pressure.

e.g. BOC Handigas™ (LPG) cylinders are fitted with pressure relief valves which operate at approximately 26 bar.



### Safety tip

Cylinders can be dangerous and can release contents given the right circumstances. BOC recommends proper Personal Protective Equipment (PPE) be worn at all times, consult your Occupational Health & Safety officer or BOC 131 262 for further details. Storage guidelines appropriate to the gas specified must be adhered to. In the event your cylinder activates any of these devices contact BOC 1800 653 572 and Emergency Services '000'.

# Ordering, transport and handling of cylinders

## Ordering gas

Take care when ordering gas. Specify the:

- Gas name (in full)
- BOC account number (Ship to or delivery account)
- BOC Gas Code
- Cylinder Size

**For example:**

Gas Specifics	Example (Oxygen)
Gas Name	Compressed Industrial Oxygen
Grade (purity)	99.5%
BOC Gas Code	020
BOC Cylinder Size Code	G

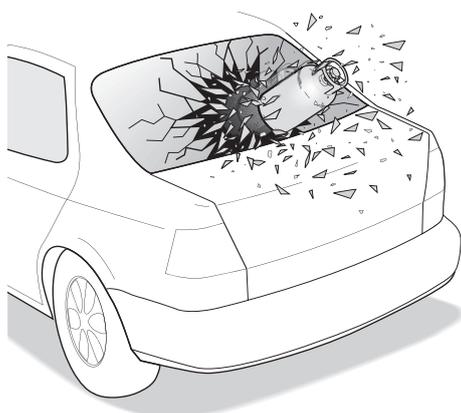
## Receipt of cylinders

Many gases cannot be seen; so the primary means of identification of a cylinder's contents is the label.

Only gas cylinders with a clearly legible shoulder or body labels are to be used.

If this is not the case, do not accept it but make arrangements to return and replace the cylinder.

Also check that what you ordered is what is stated on the label and clearly sign the delivery docket.



*Small cylinder accident example*

## Transportation

- **DO arrange for delivery of cylinders.** Goods supplied and delivered by BOC will be loaded, secured, transported and off loaded in accordance with legislative requirements wherever possible.
- **DO find out about transporting cylinders prior to your purchase.** Should you be making arrangements or picking up the cylinders or cylinder packs yourself, confirm with our Customer Service Centre the requirements for the transportation and handling of goods being collected prior to making collection.
- **DO transport cylinders properly secured and in an upright position.** Cylinders and cylinder packs are heavy and need to be properly loaded and secured prior to despatch to prevent them working loose and becoming a hazard to other vehicles sharing the road.
- **DO transport cylinders in an open vehicle.** BOC does not condone transport of acetylene cylinders in closed vehicles. There have been several violent vehicle explosions as a result of transporting acetylene cylinders in closed vehicles. Fatalities have resulted.
- If no other option exists and you must transport the cylinders in a van or car, then ensure that the cylinders have been thoroughly leak checked and ensure the vehicle is well ventilated. It is recommended no more than 10kg be transported.
- Make sure the cylinder storage area of the vehicle is properly ventilated at all times. Windows or sides must be kept partly open to ensure good cross flow of air. Secure the cylinder.
- **DO NOT transport cylinders with regulators or equipment attached** even if the cylinder valves are closed.
- **DO remove the cylinders from the vehicle immediately upon arrival** at the destination.
- **DO check cylinders have not been tampered with.** Full cylinders are supplied with caps/plugs and in some cases the valve is encapsulated in a tamper evident shrink wrap film. If these are missing, exchange the cylinder for a properly labelled and capped/plugged cylinder.

## Transporting gas cylinders

This section gives information on the hazards, safe handling and transport requirements for gas cylinders – please read the rest of this section fully before transporting gas cylinders especially in an enclosed vehicle.

### Hazards

Compressed and liquefied gases are potentially hazardous for the following reasons:

- The gas pressure is high and a ruptured cylinder or valve can cause serious injury or damage
- Heat may cause any safety device fitted to operate and release contents
- When a liquefied gas is released it vaporises and creates large amounts of gas
- Some gases are very flammable and a leakage can create an explosive atmosphere in a vehicle
- Oxygen enrichment causes material to ignite easily and will increase the intensity of the fire. Nitrous oxide has similar properties.
- Inert gases can cause oxygen deficiency and asphyxiation
- Toxic or corrosive gases are hazardous to health

Information on the hazards can be found on the cylinder label, and in the Material Safety Data Sheet that is freely available from your gas supplier.

### Risks

- **Dangerous Goods Division (Class) 2.1 Flammables (e.g. Acetylene, Ethylene, Hydrogen, LPG)** – may cause flammable or explosive atmospheres in the vehicle compartment.
- **Dangerous Goods Division (Class) 2.2 Inerts (Nitrogen, Argon, Shielding Gases)** – may cause an asphyxiating atmosphere leading to drowsiness, unconsciousness and death.
- **Dangerous Goods Division (Class) 2.2 refrigerated liquids (Liquid Nitrogen, Argon)** – evaporate to large volumes of inert gas (see above), extremely cold temperatures.
- **Dangerous Goods Division (Class 2.3) Toxic (i.e. Sulphur Dioxide)** may lead to a toxic atmosphere which is hazardous to health by breathing and/or skin contact.
- **Dangerous Goods Division (Class) 2.2/5.1 Oxidising (i.e. Oxygen, Nitrous Oxide)** – may cause some materials to easily ignite (i.e. oil) and will increase intensity of a fire.
- **Dangerous Goods Division (Class 9) – Dry Ice (Solid CO<sub>2</sub>)** – evaporate to large volumes of inert gas (see above).
- **Unsecured Cylinders** may cause damage to people, vehicles and can lead to violent cylinder rupture in transport. When transporting cylinders always ensure they are secured in place.

Note: The Dangerous Goods Division (Class) is normally clearly marked on the product label.

## Carrying a load safely

### Choosing a vehicle wisely

The vehicle must be suitable for the size and type of load.

The vehicle must be roadworthy, including:

- Tyres with sufficient tread
- Undamaged body
- Lights
- Load securing points

The vehicle must be equipped to conform to the requirements of the transport of dangerous goods regulations.

The maximum payload of the vehicle must not be exceeded.

### Positioning the load correctly

The load must be correctly positioned on the vehicle to maintain its stability.

Acetylene and LPG cylinders must always be transported in an upright position.

### Using suitable restraint equipment

The load restraint equipment and the vehicle body and attachments must be strong enough for each type of load carried, and must be in good working condition.

*This page is an extract of recommendations under Guideline 1 – Loading gas cylinders and other gas products (Australia), courtesy of ANZIGA (Australia and New Zealand Industrial Gas Association).*



## Securing gas cylinders for transport in commercial or passenger vehicles under 2.5 tonne

### General guidelines

#### Precautions

The recommended method to transport gas cylinders is by a professional gas transport company. Occasionally, there might be a need to use other transport systems and it is then essential to follow safety instructions for full and empty cylinders:

- Secure all cylinders against moving during transport. Also consider the forces in a traffic accident.
- Limit the number of cylinders to be transported.
- Use open vehicles or trailers in preference to any enclosed vehicles or trailers. Do not cover with a tarpaulin.
- Ensure that the contents label on the cylinder can be clearly read.
- Never drop cylinders or submit them to shock. This is an extremely hazardous practice which may result in serious injury.
- Where possible, use mechanical lifting devices and trolleys to move cylinders.
- Wear safety shoes or boots, safety glasses or goggles, and leather protective gloves when handling cylinders.
- When handling oxidising or flammable gases, do not smoke or use a mobile phone.

For non-flammable, non-toxic gas loads:

- An open vehicle with sides is preferable.
- Box vans may be used provided the driver's cab is separate from the load carrying area. **This means that the driver's cab is separately ventilated from the load carrying area.**

For flammable or toxic gases:

- The vehicle must have a flat bed with sides, a tailboard, and a cab which is separately ventilated from the load carrying area. Flammable gases may be carried in closed compartments separated from the driver provided there is sufficient ventilation to prevent the build-up of a dangerous atmosphere. In Australia, curtain sided vehicles are deemed to be closed compartments.
- Carrying toxic gases in any vehicle that does not have a compartment segregated from the driver is not recommended.
- Vehicles conveying drums over 300kg need not have sides provided the drums are chocked, roped and sheeted.
- Flat bed vehicles without sides must not be used, except where the cylinders are conveyed in approved pallets.
- Flammable gas cylinders must not be carried horizontally on steel-floored vehicles.
- LPG and dissolved acetylene cylinders must be carried with their valves uppermost. Cylinders, drums etc., carrying liquefied gases such as carbon dioxide and fitted with a pressure relief device must be orientated so that the pressure relief device inlet is in the vapour phase.
- **Note – Individual gas companies may refuse to load certain vehicles based upon the product to be loaded and their assessment of the risk associated with the particular vehicle.**

## Enclosed vehicles

If there are no other practical methods of transport, enclosed vehicles may be used subject to the following recommendations:

- Do not transport cylinders containing toxic or flammable gases in enclosed vehicles.
- Avoid transporting cylinders in the passenger compartment whenever possible.
- If the cylinders are in the passenger compartment, open at least one window and turn the ventilation fan on high speed when transporting the cylinders.
- If cylinders are in the boot, hold the boot lid open in a fixed position (check the car manufacturer's manual whether driving with open boot or open rear door is allowed).
- Unload the cylinders as soon as possible after arrival at destination (ventilation decreases considerably when the vehicle is stopped or parked).
- Do not store or leave cylinders unattended in vehicle overnight or for long periods (more than 1 hour).
- Do not use the cylinders in an enclosed vehicle.
- Carry a fire extinguisher suitable for vehicle fires.

When cylinders are continually transported in enclosed vehicles (such as ambulances, service vans with welding equipment, etc.) the following is recommended:

- Put a permanent system in place to secure the cylinders (gas cylinders and cryogenic liquid receptacles).
- Equip the vehicle with adequately sized ventilation openings.
- Carry the cylinders in a separate, gas-tight compartment, ventilated to the outside.

When loading cylinders at a gas supplier site or shop, the personnel responsible for the sale and/or loading the cylinders should provide the safety instructions on loading and transport to the driver and make sure that these are properly understood.

Loading and transportation of cylinders must comply with local regulations.

## Gas cylinders

Before loading a cylinder into an enclosed vehicle:

- Tighten (do not over-tighten) the cylinder valve and check that it is properly closed.
- Use the valve outlet sealing nut when available.
- Carefully check for gas leakage, (using approved leak detection fluid – see your gas supplier).
- Never transport a cylinder if a leak has been detected during loading.
- Never transport cylinders with regulators or other equipment attached.
- Do not remove any valve protection device (if fitted) during transport.

# + Guidelines for Gas Cylinder Safety

## Transporting cylinders in a passenger car

Avoid transporting gas cylinders inside the passenger compartment of passenger cars, as it is not safe. However, if you must use a passenger car or station wagon, follow the guidelines in this section, and consider the following:

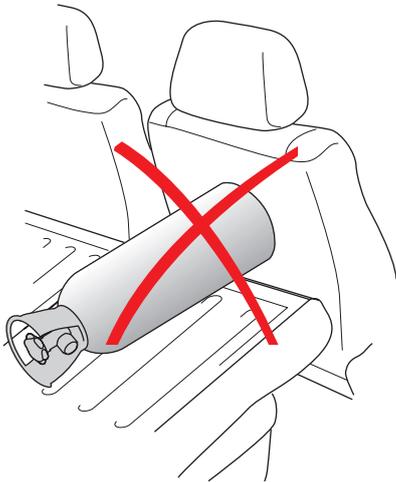
- The weight of the cylinder
- The safest place for the cylinder in the event of a crash

### Passenger car (with a boot and fixed rear seats)

If your passenger car has a fixed and sealed metal partition separating the boot from the passenger compartment, place the cylinders inside the boot. You still need to restrain the cylinders using a suitable method of tie down or blocking to prevent cylinder movement during transport.

Do not carry loose gas cylinders in the rear load compartment of a hatchback or station wagon.

The fold-down back seats of station wagons and hatch-backs are usually not designed to prevent loads such as gas cylinders from penetrating into the passenger compartment and injuring passengers in a frontal crash.



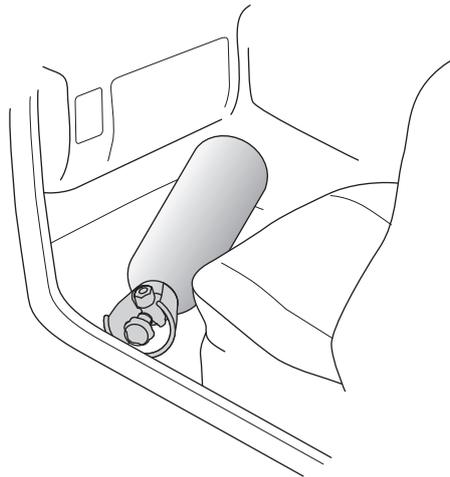
Cargo barriers fitted behind passenger seats will give additional protection, especially for loads placed immediately behind them. However, cargo barriers are not designed for use as the main restraint, and tie down or blocking is required to prevent cylinder movement during transport.

## Passenger compartments

Do not place cylinders on seats.



The safest place for a loose cylinder in a passenger compartment during a frontal crash is most probably on the floor of the passenger rear seat .



Similarly, if you must place a cylinder in the front of the passenger compartment, you are probably safer in a frontal crash if it is placed on the floor of the passenger side.

## Transporting cylinders in a van

Avoid transporting gas cylinders inside the passenger compartment of vans, as it is not safe. However, if you must use a van, follow the guidelines in this section, and consider the following:

- The weight of the cylinder.
- The safest place for the cylinder in the event of a crash.

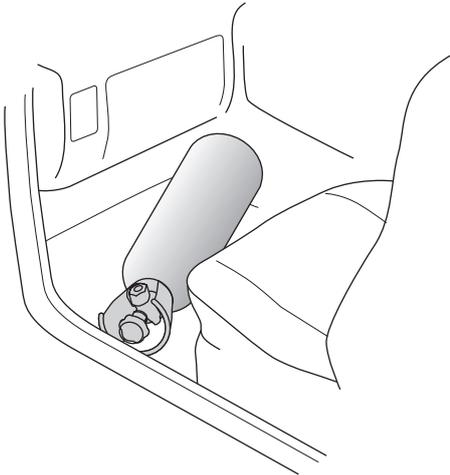
Do not carry loose gas cylinders in the rear load compartment of a van.

### Passenger compartments

Cylinders should not be placed on seats.



The safest place for a loose cylinder in a passenger compartment of a van during a frontal crash is most probably on the floor of the passenger rear seat if available or on the floor of the front passenger seat if there is no rear seat.



## Transporting cylinders in a utility

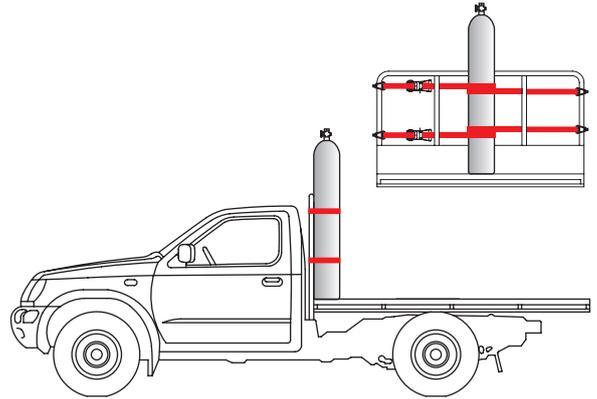
If you transport cylinders in a style-side or drop-side utility, do not place them in the cab.

### Transporting cylinders upright

Restrain cylinders by lashing them to the vehicle body or containing them in a purpose-built frame.

If transporting cylinders upright against a headboard:

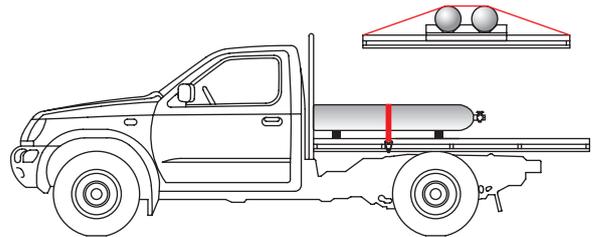
- The total weight of the cylinders should not exceed 250 kg.
- Apply at least two horizontal straps, as shown below.



### Transporting cylinders lying down

If transporting cylinders lying down:

- Place the cylinders lengthwise on the deck.
- Place the cylinders on chocks to prevent them rolling sideways and to provide more grip to stop them sliding.
- Position the cylinders with the valves facing rearwards, with the base blocked against the headboard or another strong part of the load.
- Apply at least one tie-down strap, as shown below.



Pages 16-19 of this document are an extract of recommendations under Guideline 4 – Securing gas cylinders and other gas products for transport in commercial or passenger vehicles under 2.5 tonne gross laden weight, courtesy of ANZIGA (Australia and New Zealand Industrial Gas Association).

# + Guidelines for Gas Cylinder Safety

## Emergencies and accidents

- If a gas leak occurs during the transportation of gas cylinders, where practical, stop and park the vehicle as far away as possible from other vehicles or people. Leave the vehicle and call **1800 653 572 BOC Emergency Response Line** for specialist advice.
- In the event of a fire or any other emergency, call the fire brigade and advise them of the details of your load.
- Call the emergency services should the transport vehicle be involved in a road accident whilst carrying cylinders and advise them of the details of your load, **and your location**.



Example of an incident involving the transportation of a cylinder within an enclosed vehicle.

## Lifting cylinder packs

- Packs (nominal weight 1.5 tonne) can be lifted either by crane (lifting lug centrally located on pack) or forklift truck. It is in the customer's interest to check that their vehicles and lifting devices are of adequate load capacity before ordering cylinder packs. In particular that the tynes of forklifts are sufficiently long. If side access is required for forklifts, longer than standard (1070 mm long) tynes are required, with a maximum thickness of 50 mm or less. If the stirrups in any of the forklift tyne pockets are damaged then forklifts must not be used to lift them.



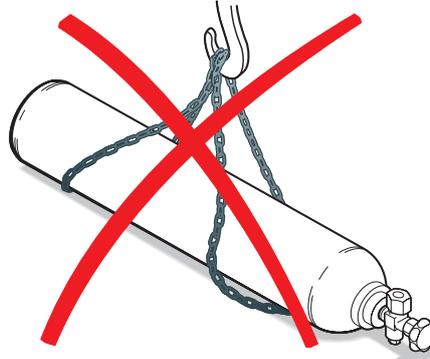
Lift Cylinder packs by forklift or by crane.

## Lifting cylinders

- Cylinders must be secured for lifting. Magnets, slings and chains are not effective as they may slip or damage aluminium cylinders.
- Cylinders, being round, are inherently difficult to secure and handle. There is a tendency for them to slide or slip away when lifting from their initial position (whether vertical or horizontal).
- Do not attempt to catch a falling cylinder. They are designed to withstand such an impact. Let it fall and move away from the

direction of impact. Most cylinder handling injuries occur when people try to prevent cylinders from falling.

- Never roll a cylinder horizontally along the ground as this may cause the valve hand wheel to become damaged or open if the cylinder valve handle strikes something. If the surface is rough it will damage the coloured paintwork identification of the cylinder.
- The use of cylinder trolleys is preferable for large cylinders (>12kg).
- Never lift a cylinder by the cylinder valve or valve handle.



DO NOT use chains or slings to move cylinders

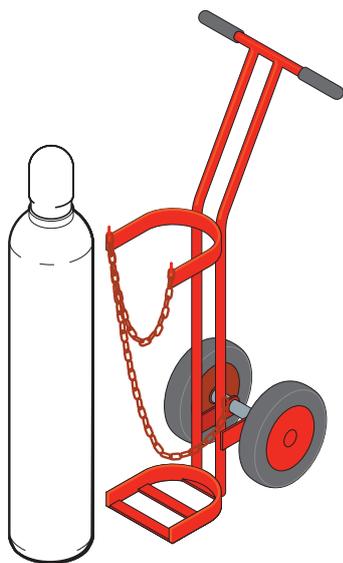
## Moving cylinders – manual risks to be aware of when handling cylinders

- Always close the cylinder valve before relocating the cylinder!
- When using a cylinder trolley to move cylinders, make sure cylinders are properly secured, and the cylinder valves are closed.
- Never transport cylinders with the pressure regulator and hose attached unless on a purpose designed trolley or carrier complete with webbing retainers. General purpose trolleys and other devices are not ideal for carrying cylinders, and should only be used if there is no other means available. Remove the pressure regulators and ancillary equipment and secure the cylinder.
- Never use cylinders situated remotely in a storage compound.
- Cylinders should always be removed from the storage compound, (see next page) transported by a cylinder trolley and secured and positioned adjacent to the workstation for immediate access to the cylinder valve and regulator.
- Once in place, the cylinder must be secured by cylinder wall brackets, before ancillary equipment is connected.

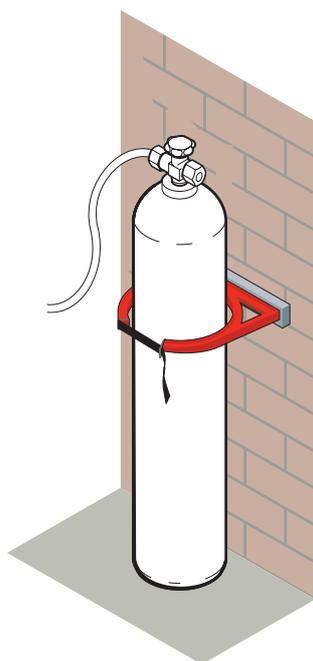


Ensure Cylinder valve is closed before moving or disconnecting equipment

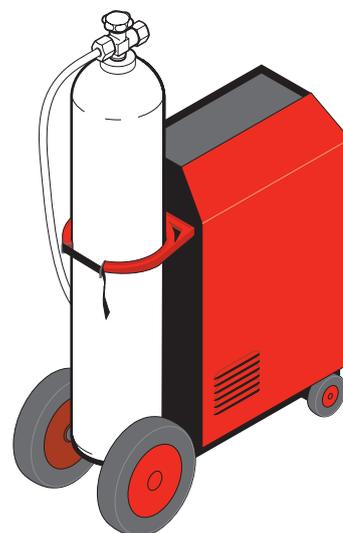
## Securing cylinders



Cylinder trolley



Cylinder wall brackets



Cylinder bracket on welding machine

## Handling gas cylinders — general safety

- **DO** use mechanical aids (ramps, trolleys, forklifts, scissor lifts) in preference to direct manual handling of cylinders.
- **DO** remove any connected equipment (e.g. regulator) AND refit any supplied valve protection cap and/or valve outlet gas tight cap/plug prior to moving cylinders.
- **DO** ensure cylinders are positively secured to mechanical lifting/handling devices prior to movement.
- **DO** familiarise yourself with and observe appropriate safe lifting techniques/postures prior to manually handling heavy or large gas cylinders.
- **DO** assess the load weight and dimensions before attempting any lift.
- **DO** use suitable personal protective equipment (PPE) – wear safety footwear and leather gloves to protect against falling/slipping cylinders crushing hands or feet during moving.
- **DO** ensure a positive hand grip prior to commencing a manual lift.
- **DO** ensure that loads are equally shared when attempting two-person lifts.
- **DO** note environmental conditions prior to handling cylinders – wet, hot or cold cylinders may diminish the quality of hand grip and footing may be compromised.
- **DO NOT** bear-hug cylinders to effect a lift.
- **DO NOT** lift or lower cylinders where the operators hands are above shoulder height or below mid-thigh height.
- **DO NOT** edge-roll cylinders up or down steps of 250mm or higher.
- **DO NOT** edge-roll cylinders over discontinuous or soft surfaces.
- **DO NOT** attempt to catch or restrain a falling cylinder.
- **DO NOT** attempt to handle cylinders if you are fatigued, physically compromised or under the adverse influence of medication or alcohol.
- **DO NOT** drop cylinders as a method of transfer – this may seriously damage the cylinder or its valve, resulting in their failure and product release.

*Recommendation under Manual Handling Gas Cylinder, as endorsed by ANZIGA (Australia and New Zealand Industrial Gas Association).*

# Storing your cylinder safely

## Storage locations

- **Small** quantities of cylinders may be stored in a variety of locations, provided Dangerous Goods and local government regulations and the principles given in the following paragraphs are followed.
- **Larger** quantities of cylinders should be kept in a purpose-designed store or storage area, following the same principles.

## Ideal storage

Full or empty compressed gas cylinders should be stored

- in a well ventilated area,
- preferably in the open,
- with some weather protection.

The area on which cylinders are stored must be well-drained to prevent corrosion of cylinder bases. The location must be free from the risk of fire and well away from sources of heat or ignition.

## Store cylinders standing vertically and secure them

1. It is recommended to store cylinders vertically.
2. Vertically stored cylinders must always be secured or under your direct control. When standing or rotating and 'walking' cylinders about their vertical axis, be aware of the hazards of uneven sloping, slippery and unstable surfaces as well as loose surfaces. Secure cylinders to prevent them falling as unsecured cylinders are a potential hazard to users and passers-by should they inadvertently bump them.
3. Acetylene and LPG must never be stacked horizontally in storage or in use.
4. Whenever possible use a cylinder trolley for transporting cylinders higher than one's waist height.

## Plan for emergencies

### Ensure free and clear access to cylinder storage areas

All persons with a responsibility for storage or use of gas cylinders must be familiar with the emergency procedures. Store layouts and emergency procedures need to be structured accordingly and to cater for such possible incidents.

### Cylinders should be stored in dedicated cylinder-only areas

You must not store any other products in a cylinder store, particularly oil, paint or corrosive liquids.

## Rotate your stock

Your storage arrangements should ensure adequate turn around of stock. Do not store empty cylinders longer than necessary; return them to BOC as soon as possible. This applies particularly to cylinders which normally contain flammable or toxic gases.

## Wear the correct Personal Protective Equipment (PPE)

All persons handling gas cylinders must wear the correct PPE. Safety shoes, safety glasses plus ear protection are essential. The correct grade of gloves (where appropriate) may also be required.

In many places, safety signs will designate where and what PPE is to be worn. Loose clothing and hair is an entanglement hazard, and steps must be taken to avoid this.

## Storage and segregation of cylinders

Within the storage area, oxidising gases such as oxygen must be stored at least 3 metres away from fuel gas cylinders (refer to pg 8 for types). The use of an appropriately fire rated wall may provide the required separation.

Full cylinders must be stored separately from the empty cylinders, and cylinders of different gases whether full or empty must be segregated from each other.

Where security is an issue, there is available a wide variety of Gas Cylinder Storage Systems which satisfy the cylinder storage requirements of AS 4332.

Contact BOC on 131 262 for details.

## Storage of toxic gases

Toxic gases must be stored separately from all other gases and the detailed instructions on the individual BOC Material Safety Data Sheets (MSDS) must be followed.

It is essential that when handling or storing cylinders containing toxic gases that the cylinder valve outlet threaded plug or cap is always replaced in the valve outlet when the cylinder is not in use or connected to a manifold or regulator. The cylinder valve outlet threaded plug or cap acts as a secondary valve to the valve itself and provides increased safety against leakage.

In an emergency involving toxic gas or other BOC Special Gases product, contact BOC Emergency Assistance on 1800 653 572.

For full details of local storage requirements consult the State Dangerous Goods regulations, and AS 4332.

## Storing your cylinders safely

All cylinders should be considered and treated as full, regardless of their content. This means:

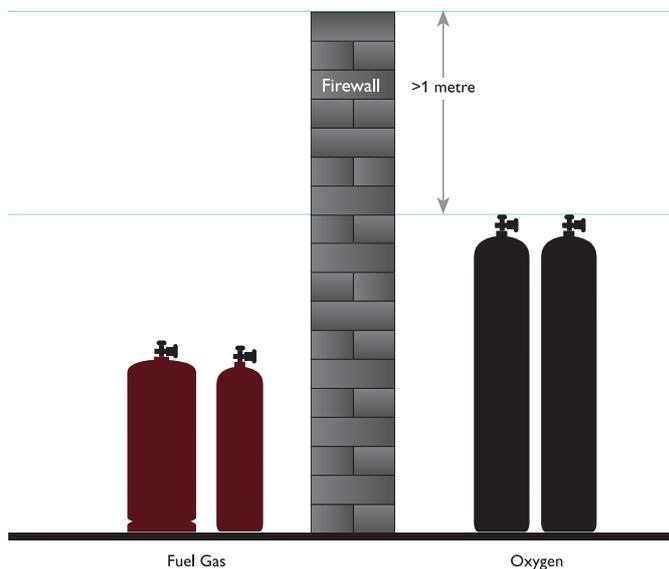
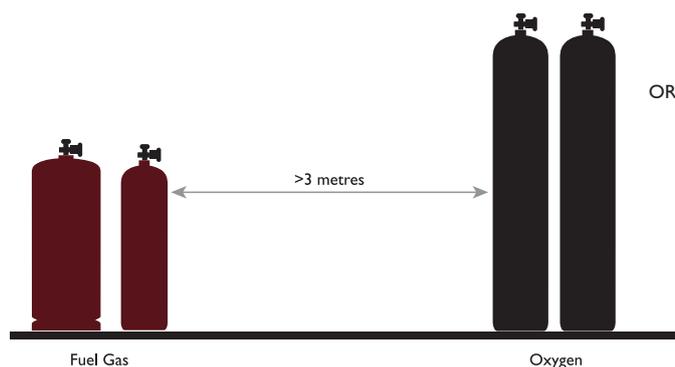
- Keep cylinders away from artificial heat sources (e.g. flames or heaters).
- Do not store cylinders near combustible materials or flammable liquids.
- Keep flammable gases away from sources of ignition.
- Keep cylinders in well drained areas, out of water pools or ponds.
- The storage area should be kept well ventilated and clean at all times.
- Do not store in confined spaces.
- Avoid below-ground storage where possible. Where impractical, consider enclosed space risks.
- There should be good access to the storage area for delivery vehicles. The ground surface should be reasonably level and firm (preferably concrete).
- The storage area should be designed to prevent unauthorised entry, to protect untrained people from hazards and to guard cylinders from theft.
- Different types of gases must be stored separately, in accordance with State Dangerous Goods legislation (Hazardous Substances Legislation in NZ). Also refer to AS4332 (The Storage and Handling of Gases in Cylinders).

- Stores must clearly show signage in accordance with state Dangerous Goods regulations. This includes Class Diamonds; HAZCHEM; no smoking and naked flame warning signs.
- Full and empty cylinders should be kept separate.
- Toxic and corrosive gases should be stored separately, away from all other gases.
- Liquefied flammable cylinders must be stored upright, to keep the safety devices in the vapour phase, on a firm, level floor (ideally concrete). This is also preferable for most other gas cylinders.
- Store cylinders away from heavy traffic and emergency exits.
- Rotate stock of full cylinders, and use cylinders on a 'first in, first out' basis.
- Never repaint or obscure a cylinder label, even if the cylinder is rusty, dirty or damaged. This can result in unsafe situations.
- Never apply any unauthorised labels or markings to cylinders, unless advised by BOC to identify faulty cylinders.
- Avoid storing cylinders below 0°C. Some mixtures may separate below this temperature.
- Regularly check for leaks and faults, only with approved leak detection fluid.
- Keep ammonia-based leak detection solutions, oil and grease away from cylinders and valves.
- Never use force when opening or closing valves.

## Storage of fuel gases

Within the storage area, oxygen should be stored at least 3 metres from fuel gases cylinders. The use of a fire wall may provide the required separation. If volume is greater than 200 m<sup>3</sup> a separation distance of 5 metres needs to be executed.

Note: wall must be a minimum of one metre higher than the tallest cylinder.



# Care of cylinders

## Most accidents are avoidable

The majority of accidents involving compressed gas cylinders are avoidable with increased training and awareness of safety issues.

## Cylinders need to be kept cool

**Do not store cylinders at temperatures greater than 65°C.**

All efforts should be made to keep the cylinders well below the maximum ambient air temperature. Under extreme temperatures every effort should be made to keep the cylinders in the shade.

**Excessive heat** – results in an increase in internal pressure.

Excessive heat can reduce the strength of the cylinder resulting in localised bulging at the source of the heat and in extreme cases cylinder rupture. Care must be taken with an oxy-fuel gas torch when in use. **DO NOT** allow the flame from an oxy-fuel gas torch or other appliance to point onto cylinders.

The plastic Test Date Tags (TDTs) fitted by BOC on the cylinder valve inlet connection distort or melt at a predetermined temperature as shown when heat affected. This is to alert BOC gas cylinder re-fillers (and customers) of any heat damage to the cylinder. Any such heat affected cylinders are sent to our cylinder test shops to check if the cylinder can be returned back into gas service or be scrapped.



Before

After

Heat indicator test date tags (view from tag underside – without markings)

## Handle cylinders carefully

**Damage** – take care in handling cylinders to avoid impact damage. Do not drop cylinders off vehicles or docks when unloading or allow heavy objects to fall on them.

Impact damage can potentially reduce the cylinder wall thickness, which could lead to premature cylinder rupture.

**Barcodes** – are to alert the fillers and operators when the cylinders are due for re-test, and for identification purposes.

**DO NOT** under any circumstances tamper with or remove these.

## Keep cylinders away from electric welding tools, red-hot metals, furnaces or any heat sources

Keep electrical welding equipment well away from cylinders. Do not allow welding torches to contact or get near to cylinders.

An accidental arc between the tool and the cylinder could cause localised overheating of the cylinder wall and thereby weaken the cylinder.

## Anything hot must be kept away from cylinders.

Take care not to allow welding and cutting sparks, flames or red hot slag to make contact with the exterior of cylinders, or their associated cutting equipment and/or hoses. Keep cylinders a safe distance from potential accidental spillages of molten metal.

If any of these hot items reach an acetylene cylinder, it will melt the fusible plugs and cause a release of acetylene gas and fire from the cylinder.

## DO NOT

- put any cylinders adjacent to a furnace;
- put LPG cylinders near boilers or heaters;
- use cylinders whether full or empty as any kind of support structure.

## NEVER

- NEVER let oil or grease contact your cylinder or its valve and fittings; use sealants or lubricants when connecting gas fittings or equipment.
- NEVER use cylinders as support structures.
- NEVER roll them along the ground.
- NEVER lubricate cylinder valves and fittings.
- NEVER apply sealants (liquid or tape form) or lubricants to any cylinder valves or connecting fittings.

High pressure oxygen will react violently with oils and grease and cause a violent explosion or localised ignition leading to injury of the user and damage to equipment.

Oxygen equipment is at most risk from oil and grease so keep greasy hands, rags and gloves away from any part of the cylinder and fittings.

Wipe hands clean and try to minimise hand contact with surfaces which might be subject to oxygen under pressure.

## Keeping cylinder valves clean

Cylinders are supplied with their cylinder valve outlets capped or plugged and in some cases PVC shrink wrapped.

The purpose of this is two fold:

1. To indicate the cylinder is full and
2. To keep the outlet clean and contamination free.

Top outlet valves, are particularly prone to dirt getting in the outlet.



Top outlet valve showing a test date tag

If grit, dirt, oil or dirty water enters the cylinder valve outlet, this may cause damage to the valve internals and result in leakage.

Before assembling regulators and fittings make sure there are no particles of dirt in the cylinder valve outlet. If a supply of clean compressed oil free air or nitrogen is available, then, whilst wearing appropriate eye and ear protection, use this to blow out any loose particles of dirt from the valve outlet.

If a supply of clean compressed oil free air or nitrogen is unavailable, then use a clean lint free rag to clean the cylinder valve outlet, in particular the sealing surfaces.

**Never open a cylinder valve to clear the outlet. For flammable gases this often leads to the ignition of the escaping gas. Ejected particles and resultant noise can also injure adjacent personnel.**

## NEVER attempt to repair a cylinder

If a cylinder is involved in an incident (especially cylinders involved in fires) it must be:

- withdrawn from service
- set aside and made clearly identifiable
- identified to the supplier – contact BOC (See also pages 32–34)

## NEVER disguise damage to cylinders

If a cylinder has been involved in a fire, never paint over the discoloured or heat affected areas. Heat damaged cylinders must be drawn to the attention of the Gas company so that detailed examination can be carried out to determine whether the cylinder(s) concerned can be repaired or need to be condemned.

Incidents have occurred where third parties have disguised damage to a cylinder which has resulted in a rupture of the cylinder when next refilled.

**Cylinders must never be tampered with or relabelled by anyone other than the cylinder owner.**

## NEVER mix gases in a cylinder

Users must never mix gases in a cylinder; this must only be undertaken by an authorised competent gas specialist personnel with suitable equipment and facilities under controlled conditions.

## NEVER transfer gas to another cylinder

Never transfer, transfill or siphon gas from one cylinder to another. This can result in serious accidents.

## NEVER scrap a cylinder you do not own

Most gas cylinders are owned by gas companies. There are however small numbers of privately owned cylinders (POC's). These can be individuals, companies or Government institutions. Ownership is indicated by the cylinder label. If the label is missing, ownership can be established by the permanent stampings on the cylinder shoulder. If BOC discovers a cylinder to be defective and must be condemned, BOC will contact the owner for their permission to scrap it.

Scrap metal merchants and recyclers must never buy gas cylinders as scrap metal unless the cylinders have been condemned by an AS authorised Test Shop.

If intact valved cylinders are discovered amongst recycled scrap, these must be set aside and the owner contacted with relevant particulars (i.e. colour, service, number and markings, in most cases this will be one of the gas companies) to make arrangements for their collection and return.

## NEVER use equipment with cylinders for which they are not intended

Do not attempt to make any adaptors or pipework to cross connect cylinders as this is potentially dangerous.

# Working with gas cylinders

## Use of gas cylinders and associated equipment

### Safe connection of equipment

#### Cylinder valve operation

Use care when opening cylinder valves. Slowly open (anticlockwise) the cylinder valve using the hand wheel or (in a small number of cases) the cylinder valve key (obtainable from BOC Gas and Gear centres)

N.B. Soft seat, spindle key operated cylinder valves should not be subjected to excessive torque. Use the correct spindle key and only use moderate hand torque.

An opened valve should never be left against the backstop (i.e. fully opened until resistance is encountered), but should be turned back at least half a turn to avoid seizure in an open position. This can occur if the valve is left open for long periods of time.

When you shut the valve turn it clockwise and just enough to stop the gas completely. Never wrench it closed.

Remember **all** cylinder valves are closed by turning the hand wheel in a clockwise direction. If you are going to stop work for a while (e.g. morning tea break, etc.) then close the cylinder valve.

#### Acetylene cylinders are to be used standing vertically on their base

Acetylene cylinders are transported standing vertically and are designed to be used in an upright position. For this reason, always store and leave these cylinders standing vertically.

Should acetylene cylinders have been stored or transported horizontally, place the cylinders in a vertical position and allow 4 hours before use.

**For the few cylinders now still fitted with cylinder valve keys, only use the recommended cylinder valve keys.**

- NEVER increase the leverage of keys by fitting handle extensions.
- NEVER use spanners with long handles.
- NEVER use badly worn cylinder valve keys.

Any of the above will damage the square end of the spindle or the valve's soft plastic (usually Nylon) seat.

If the valve spindle is too stiff to open by hand with the cylinder key, return the cylinder for exchange.

#### Sheared valve keys

N.B. Most cylinders are now supplied with hand wheels so this will be a rarity.

If you believe your cylinder valve has a broken or damaged spindle, (e.g. the cylinder valve key rotates without the valve opening) do not persevere any further. Tag the cylinder valve as defective and add the date, plus a contact phone number, and call BOC on 131 262 for a replacement cylinder.

## Only use equipment that is fit for purpose

The gas cylinder and outlet valve are designed to supply gas through pressure regulators that meet the requirements of the relevant Australian Standards.

Pressure regulators thread directly to the cylinder valve outlet (also applies to cylinder packs) so it is vital that the size and tolerance are to specification and meet the specified machining tolerance.

**Never** install additional piping or fittings between regulators and the outlet valves of cylinder packs.

When individual cylinders of the same gas are manifolded together to a common outlet, the pressure regulator must be connected to this single manifolded outlet.

Use the adjustment valves downstream of the pressure regulator only and not those fitted upstream, as this will starve the regulator of flow.

### Pressure regulators: check the inlet spigot connection first

Make sure the pressure regulator is designed for use with high pressure gas cylinders and that the inlet spigot thread matches the cylinder valve outlet and that the O-ring or seal is in place, clean and undamaged.

Never force any regulator connection that does not fit. Regulator connections can be fully threaded in by hand and then only require a fraction of a turn to achieve a gas tight seal. Regulators must be maintained in accordance with the manufacturer's instructions.

Do not attempt to repair or modify the regulator. Take it to the manufacturer's authorised service centre.

**Release** (i.e. turn anti-clockwise, 'back off') **the regulator adjusting knob before attaching the pressure regulator.**

**Before connecting a pressure regulator to a full cylinder always screw out (anticlockwise) the pressure adjusting knob so that there can be no flow through the regulator when the cylinder valve is initially opened.**

Only use the gas for the intended purpose.

Gas cylinders with their associated regulator and reticulation equipment are supplied for use in their intended application.

These uses are covered in gas supplier catalogues.

Do not experiment with gas or gases. If in doubt and expert assistance is required then please consult with our Technical Service desk on 131 262.



1	Outlet or Regulated Pressure Gauge	
2	Inlet or Cylinder Pressure Gauge	
3	Regulator Outlet Connection	
4	Inlet Spigot (regulator)	
5	Cylinder Valve	
6	Regulator Control Knob	Increase Pressure (Turn Clockwise) Decrease Pressure (Turn Anti-clockwise)

## Do not use oil or packing on any regulator – oxygen or not

Never try to ease any regulator threads with oil: do not use PTFE tape. This advice applies to all gas cylinders and regulators.

Never pack out or use any connection that appears worn when tightening or loose when fully screwed home.

## Fuel gas (Hydrogen, Handigas™ (LPG), Acetylene): use only the regulator designed for the gas

Do not interchange left-hand threaded pressure regulators between gases. Each is designed for use with a specific gas, and to interchange them could be hazardous. Remember the cylinder pressure and properties are different for each gas.

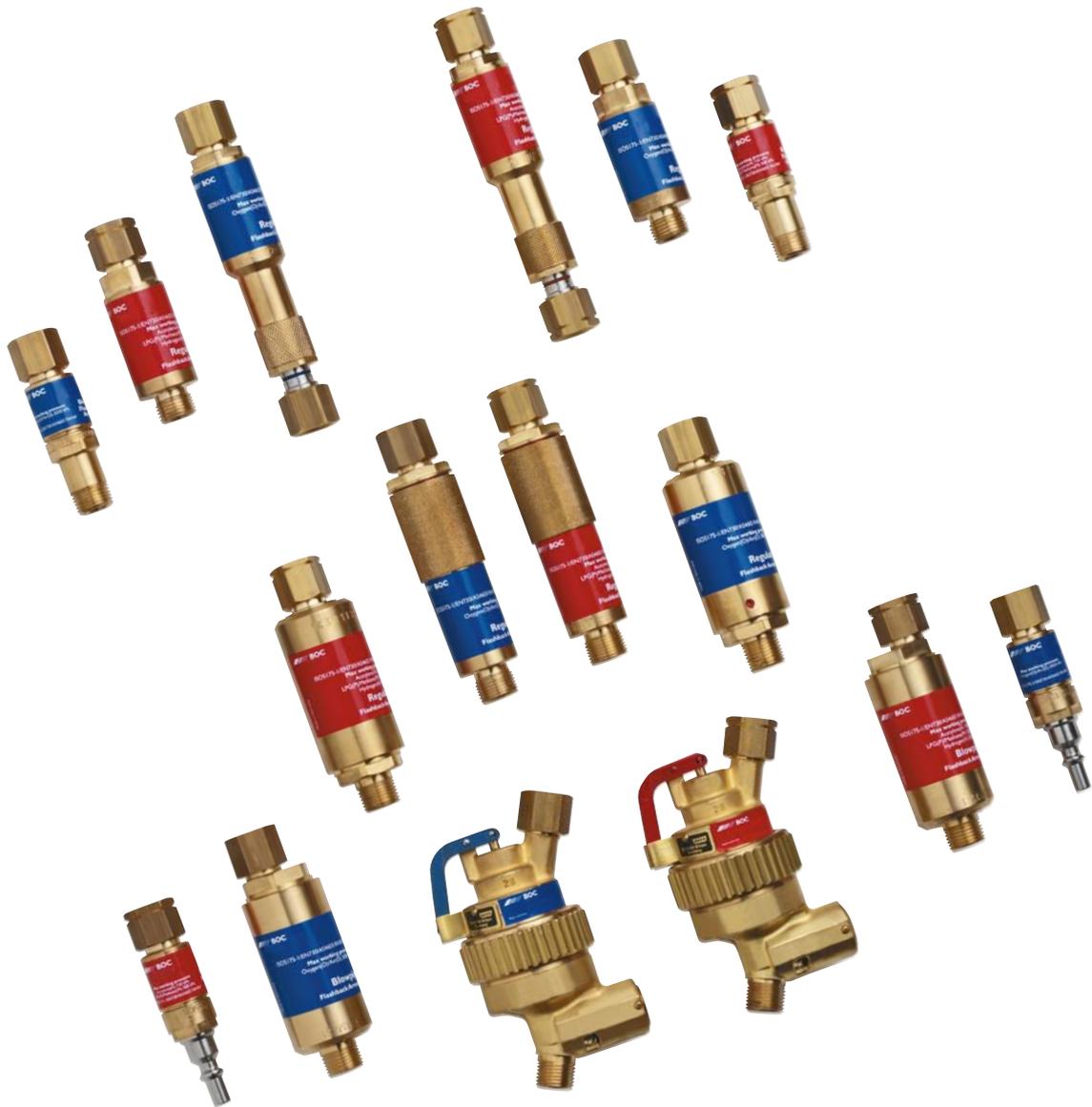
Do not use left-hand to right-hand adaptors.

## Fit flashback arrestor

To prevent flames travelling back into cylinders, devices known as flashback arrestors should be fitted downstream of pressure regulators in Oxygen, Acetylene, Handigas™ (LPG) and Hydrogen systems where flammable mixtures can occur.

## Does your manifold have the right regulators and flashback arrestors?

Where cylinders are connected to a manifold the system must be properly designed for the task and installed by a competent trained technician. It must be fitted with one or more pressure regulators. Acetylene manifolds must also be fitted with a flashback arrestor.



Selection from the BOC Flashback Arrestors' range.

## Choosing safe equipment

### Pressure regulator: be guided by the gas supplier

Where a pressure regulator is fitted with gauges (content and delivery pressure), these should never be removed, exchanged or tampered with in any way. Replacement gauges are available from your local BOC branch and should only be fitted using oxygen safe tape.

### Hoses: use the right colour and the right quality

Only use hose that conforms to the relevant Australian Standard (AS1335 for oxygen, acetylene and LPG hose used for welding, and AS1896C for LPG hose for industrial applications). Hoses should be colour coded in accordance to the same standards.

#### Colour coding for hoses

Gas	Colour
Oxygen	 Blue
Acetylene	 Red
LPG	 Orange



Never use LPG hose for acetylene, never use water hose.

### Hoses: use the right end connection

BOC twin hose is supplied with the correct threaded connections (left handed for fuel and right handed for oxygen) to fit either the pressure regulators or flashback arrestors.

Hose connections must conform to the Pressure and Tensile requirements as laid down in AS1335 and AS/NZS1869 for LPG.

Incorrect hose connections are a frequent cause of accidents. Check connections regularly.

Remember to purge hoses and check for leaks and visible signs of damage before lighting a cutting or welding torch.

### Flashback arrestors

A flashback is a flame, travelling at supersonic speed, in the opposite direction to normal gasflow in oxy-fuel gas equipment. The use of flashback arrestors is required to limit the potential damage that may result if a flashback occurs. If not stopped, a flashback can melt the equipment which, in the worst case, could explode and travel back to the cylinder.

BOC flashback arrestors have a sensitive non-return valve that stops the gasflow and a fine sintered filter that quenches the flame. On the BOC regulator end of the flashback arrestor, a thermal cut-off valve is built in. This valve will stop the flow of gas before ignition upstream occurs.

To ensure total safety and protection from the causes and effects of flashbacks, BOC flashback arrestors should be fitted to each gas line, as the risk of a reverse flow of gas exists with both oxygen and fuel gas. According to AS 4839 flashback arrestors should be tested every year.

### Do not use longer hoses than necessary

For fixed installations according to AS 4289.

For safety purposes, hoses shall be installed as follows:

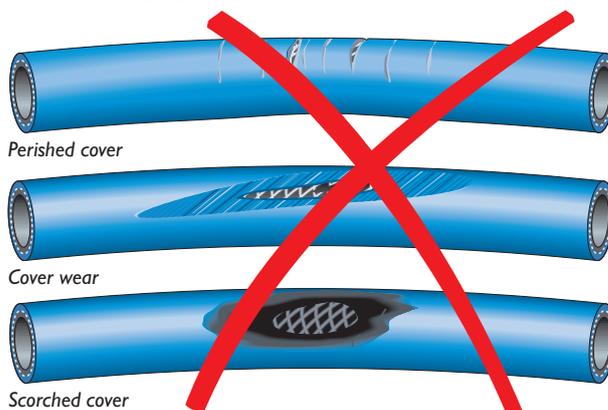
- Protected from heat, mechanical damage, traffic sparks, slag, and oil or grease. They shall be as short as possible. Where longer lengths are needed, extension hoses, coupled by means of hose connectors suitable for use with oxygen and acetylene, may be used, but only occasionally.
- Copper pipe shall not be used to couple hoses carrying acetylene.

For portable equipment according to AS4839:

- The maximum hose length shall be fifteen (15) metres for each gas, or such a distance which will allow the operator of hand-held equipment to be in sight of all supply cylinders, whichever is the smaller. Hoses shall be single length.

### Do not use hoses that appear worn

Hoses showing signs of deterioration shall be scrapped.



### Use correct Personal Protective Equipment (PPE)

When welding or cutting use goggles with double lenses to protect your eyes against glare and mechanical impact from flying fragments. The inner lens should be tinted and the outer lens clear. The clear outer lenses should be changed regularly when spatter builds up.

It is also advisable to wear eye protection (spectacles or goggles) when handling high pressure gases to protect the eyes against flying dust particles in the gas stream.

Do not wear clothes made of highly combustible materials. Leather gloves or gauntlets should be used when necessary. In awkward work locations additional protective clothing may be required. Recognise the hazards of backflow and take suitable precautions.

Safety hazards can be created if contaminants are allowed to pass back into the cylinder. Precautions must be taken to ensure that when the cylinder is in use no backfeeding of gas or liquid can occur. As soon as the gas in the cylinder has been used, close the cylinder valve to avoid moisture and other contaminants entering the cylinder.

## Avoiding contamination of the cylinder

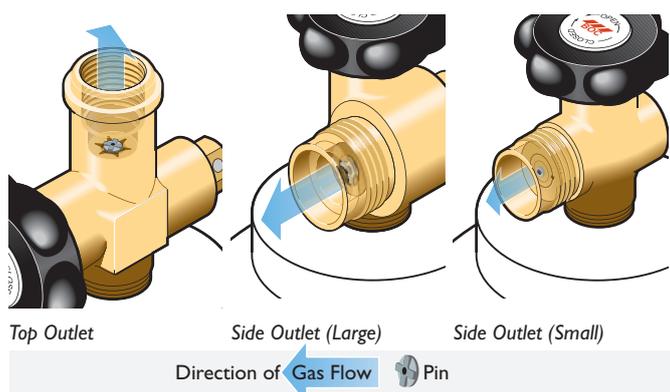
### Recognise the hazards of backflow and take suitable precautions

Minimum Pressure Retention (MPR) valves were developed to reduce cylinder contamination, such as air and moisture, caused by leaving the valve open or by connecting the incorrect equipment. More recent cylinder valves have been fitted with residual pressure device cassettes with a non-return valve (NR) function designed to counter the risk of backflow instances which can occur when manifolded cylinders together. This is commonly referred to as a NR/MPR valve (pictured below) to distinguish it from its MPR predecessor.



NR/MPR valve (Side outlet)

These valves are in both top outlet and side outlet configurations. They can be identified quite easily by examining the cylinder valve outlet. If one looks inside, a 'pin' can be seen either in the bore or protruding slightly from the bore of the cylinder valve outlet.



Note: Never damage or interfere with the operation of this pin.

If the cylinder valve fitted is not an NR/MPR cylinder valve then safety hazards can be created if gaseous or liquid contaminants are allowed to pass back into the cylinder. Precautions must be taken to ensure that when the cylinder is in use no backflow of gas or liquid can occur.

**Also, as soon as the gas in the cylinder has been used, close the cylinder valve to avoid moisture and other contaminants entering the cylinder.**

### Take precautions to prevent backflow into the cylinder

It is particularly important to ensure that when cylinders are connected to a process in which the process pressure can exceed the cylinder supply pressure that adequate precautions are taken to avoid backflow into the cylinder. The following should be observed:

**ALWAYS** close the supply cylinder valve when not in use.

**NEVER** leave an empty cylinder connected to a process.

**NEVER** use a cylinder as a receiver for waste gas, liquid or other material.

### Practical ways of preventing backflow

If the cylinder is not fitted with a NR/MPR cylinder valve, then

**Fit a suitable, good quality 'non-return valve' (also called 'check valve')**

This is the simplest and most cost effective method of preventing backflow but it must be considered as the minimum requirement. These valves require regular maintenance as particulate matter or corrosive conditions can prevent efficient resealing.

**Fit an automatic shut-off / isolation valve**

This should be activated by a low pressure signal when the supply gas cylinder pressure reaches a level that requires the cylinder to be replaced. An alarm should normally be incorporated into the system to alert the operator.

**If you know that a cylinder has become contaminated – by whatever means or whatever the contamination – inform BOC and label the cylinder before it is returned giving any relevant information about known or suspected contamination.**

**This information is required even if the contaminant, such as water, has been emptied out of the cylinder before return.**

Cylinder contamination can compromise the:

- Quality of the gas,
- Safety of the cylinder; and as a result,
- Safety of the end user.

For this reason the pins in the NR/MPR cylinder valves and residual devices should not be tampered with.

# Keeping your equipment safe

## Equipment leak detection

### Regularly check for faults and leaks

Leaks may develop in any part of a gas system, but particularly at joints. It is important that all equipment is regularly checked and corrective action taken before use.

As a matter of routine, always check for leaks when cylinders are stored and when they are assembled with equipment for use.

When assembled, special attention should be paid to all joints and blowpipe valves. Use a BOC approved LDF (Leak Detection Fluid) or an ammonia free, soapy water solution applied with a brush.

**Warning** – beware of the dangers of using leak detecting fluids which are incompatible with oxygen as the residues from LDFs could cause spontaneous ignition. It is recommended to only use BOC approved LDFs.

Wipe the area dry with a clean lint-free cloth after you have completed the check. If there is any bubbling or foaming of the leak detection fluid during testing this indicates leakage. The equipment should be immediately depressurised and the leak corrected.

- **NEVER use a flame when testing for leaks**
- NEVER tighten equipment while the equipment is under pressure

### TIPS on equipment safety

- Pay special attention to pressure regulators. If a regulator is defective or if a pressure gauge is broken, have it replaced immediately.
- Have any hose that shows signs of deterioration replaced.
- Examine the blowpipe nozzle regularly and if it is becoming clogged, clean it in the manner described by the manufacturer.
- Keep equipment clean. In particular oxygen regulators must be kept in a clean area when not in use.
- Leakage around the valve key of the cylinder valve will be revealed by either hissing or, in the case of fuel gases, by an odour.

If in doubt, contact BOC on 131 262 for advice. Remove cylinder to remote well ventilated area.

### Do not use coiled hoses

Ensure that both hoses are of equal length. Do not coil surplus hose around the cylinder, regulator or on the floor adjacent to cylinder in storage or use.

A fire in a coiled hose is very difficult to extinguish.

If you do have surplus hose, position it behind you to keep it clear of sparks.

# If something goes wrong

**In all emergencies, phone Emergency Services on 000, and always use protective clothing and equipment**

## Gas cylinders in fires

### Actions to be taken when fire is discovered

#### Gas cylinders involved in a fire may explode.

If cylinders are in a fire the key actions to be taken are:

- Evacuate the area (min. 100m).
- Call the fire brigade.
- Advise persons between 100–300m from the cylinder to take cover.
- If you attempt to fight the fire, do so from a protected position such as behind heavy machinery or a solid wall using copious quantities of water. Otherwise keep away, do not approach or attempt to move the cylinder, do not attempt to open the valve.
- When the fire brigade arrives inform them of the location and number of gas cylinders directly involved in the fire, and the names of the gases they contain.
- Cylinders which are not directly involved in the fire and which have not become heated should be moved as quickly as possible to a safe place – provided this can be done without undue risk. Make sure these cylinder valves are closed.
- As soon as possible inform your local BOC branch of the incident.
- Do not use cylinders that have been exposed to a fire until BOC has examined them.

Remember that even after the fire has been extinguished some cylinders which have been heated can explode, particularly acetylene cylinders.

### Cylinders exposed to a heat source

Cylinders which have been exposed to excessive heat – such as fire or by accidental impingement of a flame – may fail when next filled and may result in an operator's death.

ALWAYS clearly mark fire exposed cylinders and advise BOC.

**Under no circumstances should you clean or repair the cylinder!**

**Do not use any fire damaged cylinders**

### Leaking cylinders

Leaking cylinders may lead to fire or explosion when it meets an ignition source.

Do not enter an atmosphere which may contain a flammable gas/vapour and air mixture in the flammable range without either:

- a) testing that the flammable gas/vapour content is less than 20% of the Lower Explosion Limit (LEL) or
- b) ventilating prior to entry to achieve (a).

(Do not use electrical fans etc. to ventilate unless flameproof.)

### Leaking acetylene cylinders

#### 1. Where an ignition has not occurred.

Try to stop the leak by closing the cylinder valve. If the leak cannot be stopped then as long as

- a) there is no ignition of the escaping gas, and
- b) the cylinder is not becoming hot

then to prevent ignition and resulting harm to people and/or property, take the following actions:

- Avoid any source of ignition.
- Evacuate uninvolved personnel from the area.

- If safe to do so, remove cylinder outside to a well ventilated area, carefully avoiding shocks, bumps, and ignition sources and staying out of the path of escaping gas in case it ignites.
- Inform your BOC depot.
- Ensure the work area is thoroughly ventilated before re-entry.
- Hot acetylene cylinders must be dealt with as set out in the paragraph 'Gas Cylinders In Fires'.
- If the leak has ignited then follow the recommendations below:

## 2. Where an ignition has occurred

Only when it can be done immediately after ignition, close the cylinder valve to stop the gas flow. Feel the cylinder shell with bare hands for any rise in temperature.

If

- The cylinder becomes hot
- The flame or gas flow does not stop
- There is any doubt or other reason

Then

- Evacuate the area 200m direct line of view of the cylinders.
- From a protected position spray water on the cylinder to keep it cool and continue the water spray until the fire brigade arrives.
- Eliminate all other sources of ignition.
- Inform BOC on the Emergency Response line 1800 653 572.

A flame from an acetylene cylinder which is in a room and whose valve cannot be closed shall normally be left to burn while cooling the cylinder with water. If the flame is extinguished, the acetylene continues to escape and can re-ignite and result in/cause a fire or explosion. The flame may only be extinguished if:

- It can give rise to a dangerous situation. In such a case, apply the relevant recommendations in 2 above and ventilate abundantly and naturally.
- The acetylene flow is very small and the acetylene cylinder can be safely and quickly carried out in the open air, in a safe place.

Ensure working area is well ventilated before re-use. In all other circumstances, keep the cylinder cool until the fire brigade arrives.

Even once the fire has been extinguished, dissolved acetylene cylinders need to be cooled for a total of 24 hours.

BOC will arrange for collection of the cylinder after the 24 hour cooling period.

## Leaking LPG Cylinders

### 1. Where an ignition has not occurred

If a leak has occurred but not ignited, which cannot be stopped by closing the valve, do not attempt to tighten the cylinder valve in the body or tamper with safety devices, but take the following actions immediately:

- Call the fire brigade.
- Eliminate all sources of ignition.
- Evacuate the area.
- Remove the cylinder to a safe position outside, at least 100m direct line view of the cylinders. If possible keep the leak facing up. Keep away from drains.

- Warn everyone in the area of the gas leak giving priority to those downwind and downhill.

### 2. Where an ignition has occurred

- Call the fire brigade.
- If the valve is accessible and it is safe to do so, attempt to close the valve.
- If the flame from the cylinder has started a secondary fire which is heating the cylinder, evacuate the area 100m around the cylinder.
- If possible cool the cylinder with a water spray from a protected position.

## Leaking hydrogen cylinders

CARE! Hydrogen burns with an almost invisible flame. Burning hydrogen can be detected by the feel of heat, looking for signs of heat shimmer in the air and falling droplets of water.

**1. If a leak has occurred but not ignited**, which cannot be stopped by closing the valve, do not attempt to tighten the cylinder valve in the body, but take the following actions:

- Eliminate all sources of ignition.
- Remove to a safe position outside.
- Inform BOC depot.
- Ensure the work area is thoroughly ventilated before re-use, particularly at high level.

### 2. If the leak has ignited:

- Call the fire brigade.
- If the valve is accessible and it is safe to do so attempt to close the valve (take care as a hydrogen flame is almost invisible).
- If the flame from the cylinder has started a secondary fire take key actions as set out in the paragraph headed 'Gas Cylinders in Fires' on page 32.

## Leaking toxic gases – ammonia

The odour of ammonia is very characteristic and quite recognisable, providing adequate warning of its presence.

Ammonia is a primary irritant which is severely irritating to the skin and to the mucous membranes of the eyes, nose, throat and lungs. Ammonia is flammable in air only at comparatively high concentrations (15-28% by volume in air). These limits are seldom encountered in practical handling.

Do not enter an atmosphere which may contain toxic gas without either:

- a) testing that no toxic gases are present, or
- b) wearing Self Contained Breathing Apparatus (SCBA).

The precautions to be taken with toxic gases are the following:

- Leak-check systems by pressurising with inert gas before admitting toxic gas, and using leak detection solution on joints.
- Provide good local ventilation or mechanical extraction.
- Use a gas-specific leak detection method.
- Install atmospheric monitoring and alarm (this may be mandatory by legislation).

- Assure breathing quality air for:
  - Normal operations
  - Emergencies
- Have on hand:
  - MSDS
  - Emergency equipment
  - Specific operating and emergency procedures

## Leaking asphyxiant gases

Gases which create a hazard by displacing oxygen are called simple asphyxiants.

Poisonous gases are hazardous at parts per million in the atmosphere. Flammable gases enter the flammable range at a few percent in the atmosphere. However, any gas whether poisonous, flammable, non-flammable, toxic or non-toxic can create an additional hazard if its concentration lowers the oxygen concentration to 19% or less.

## Risk of altered gas concentrations

Because gases are stored under pressure, gases leaking out of the storage container into the working atmosphere may displace other gases in the atmosphere, upsetting the normal balance.

Do not enter an atmosphere which may be deficient in oxygen without either:

- a) testing the oxygen content is normal (19–23%), or
- b) wearing Self Contained Breathing Apparatus (SCBA)

Asphyxiation can cause death in seconds if the oxygen content is 0%, or minutes if it is less than 19%.

Generally there are no warning signs that an atmosphere contains increased concentrations of other gases and a deficiency of oxygen.

Any enclosed area in which gases are being stored, piped, used or vented may become deficient in oxygen.

In addition, because many gases are heavier than air, and collect in pits and drains, even small hatchways and coverings may contain oxygen deficient atmospheres.

**Do not enter these areas without appropriate Self-Contained Breathing Apparatus & Life Line.**

## Leaking oxidising gases

Because oxygen is very reactive, almost everything will react with it given the right conditions of heat and pressure.

Oxygen at high pressures in cylinders and pipework poses an extra hazard.

Do not enter an atmosphere which may be enriched with oxygen without:

- a) testing the oxygen content is normal (19–23%),
- b) dampening clothing, and
- c) avoiding sources of heat and ignition.

Poor system design can lead to hazards when using oxygen.

## Contaminants

Oxygen systems made up of “oxygen compatible” components can also be contaminated with non-compatible materials. Oil, dust, and grit are examples of contaminants that burn readily or provide a source of ignition in such systems.

## Sources of contamination

Contamination in an oxygen system can come from two sources:

- from poor cleaning of the system at the time of assembly
- from contamination introduced during its service life, either by wear of components or through incorrect maintenance procedures.

## Contamination can be ignited

Contamination that is not removed from the system can be easily ignited and can promote fires of other materials. If the fire is extensive it may rupture the system.

## Flashback to an acetylene cylinder

A flashback is the return of flame through the blowpipe or even the regulators. It may also reach the acetylene cylinder causing heating and explosive decomposition of the contents; it can be caused by faults in the equipment and/or poor procedure. In most cases a flashback does not travel beyond the cylinder neck.

You may be able to identify a flashback has occurred by:

- An audible ‘pop’ or muffled gunshot sound.
- Hot spot on the cylinder.

If a flashback occurs take the following actions, if safe to do so:

- Close both blowpipe valves – oxygen first.
- Close both cylinder valves.
- Check the acetylene cylinder shell with the bare hand for a rise in temperature (if hot or glowing, evacuate area immediately and take actions as per ‘Gas Cylinders in Fires’ on page 32.)

If the temperature of the acetylene cylinder shell rises, treat the cylinder as if it had been involved in a fire – see ‘Gas Cylinders in Fires’.

- If the temperature of the acetylene cylinder shell does not rise, unwind pressure adjustment screw on each pressure regulator.
- Check that the nozzle is not damaged and that it is tight.
- If the blowpipe is overheated, plunge it into cold water.
- Carry out the start procedure as recommended by the equipment supplier.
- If the flashback recurs immediately, the blowpipe/nozzle may be faulty and should not be used again. Again check if cylinder is heating (refer to the paragraph headed ‘Gas Cylinders in Fires’ and contact BOC).

## Frozen regulators or valves

Thaw with warm water, never by flame. This condition may be caused by excessive flow rates. Contact BOC.

## Frosted cylinders

This condition is usually due to excessive draw-off rate and can be overcome by seeking expert advice on manifolded cylinders – do not attempt to heat the cylinders.

# Keeping your environment safe

## All cylinder gases need good ventilation

Wherever cylinder gases are used you should maintain constant and thorough ventilation. The use of gases in confined spaces should be avoided where possible. Should gases need to be used in confined spaces, appropriate risk assessment and safeguards must be put in place prior to the commencement of work.

## Be aware of all possible hazards

The environment can be contaminated or adversely affected by one or more of the following hazards:

- oxygen enrichment,
- oxygen deficiency,
- accumulation of fuel gases,
- welding and other fumes,
- noise,
- fire.

## Know the danger, composition and behaviour of air

The approximate volumetric composition of the main components of air is as follows:

Oxygen	O <sub>2</sub>	21%
Nitrogen	N <sub>2</sub>	78%
Argon	Ar	1%

The atmospheric gases are non toxic, but alterations in their concentrations – especially that of oxygen – have an effect upon life and combustion processes. It is essential to have sufficient oxygen in atmospheres being breathed.

Although not itself flammable oxygen vigorously supports combustion whereas nitrogen and argon inhibit combustion.

If good practice is not observed accidents may occur because changes in gas concentration can be very rapid and cannot be detected in good time by odour or sight.

## Fire hazards from oxygen enrichment

Oxygen reacts with most elements. The initiation, speed, vigour and extent of these reactions depend in particular upon:

- the concentration, temperature and pressure of the reactants.
- ignition energy and mode of ignition.

## Combustibility of materials

Oxygen enrichment of the atmosphere, even by a few percent, considerably increases the intensity of fire. Sparks which would normally be regarded as harmless can cause fire and materials which do not normally burn in air, including fireproofing materials, burn vigorously in oxygen-enriched air.

## Smoking is not allowed where oxygen is stored or being used

Many burning accidents which occur are triggered off by the lighting of a cigarette, therefore it is impossible to over-emphasise the danger of smoking in oxygen-enriched atmospheres or where oxygen enrichment can occur. Locations where Oxygen is stored or being used are to be designated NO SMOKING areas.

## Prevent oxygen enrichment of the environment

Oxygen enrichment of the atmosphere is best guarded against by careful attention to the following points.

## Leakage of equipment

Newly assembled equipment for oxygen service should be thoroughly leak checked using an ammonia free soapy water solution or an approved leak detection fluid available from BOC. Periodic retests are recommended. Pressure drop tests are a good way to identify leaks.

All equipment, for instance welding and cutting nozzles and hose connections, should be properly fitted. Hoses and other equipment should be kept leak tight and be protected from damage. All maintenance and repair work should be carried out by experienced and fully skilled personnel.

When gas is no longer required or the shift is over, the cylinder valve or oxygen supply stop valve must be turned off, in order to avoid possible oxygen leakage in the time between the end of one working period and the beginning of the next. The gas valves on blowpipes or cutting torches should not be used to perform this task.

## Incorrect practice in the use of blowpipes

Care should be taken, especially in confined spaces, to avoid delay in lighting the blowpipe after opening the valves.

When flame cutting, besides the oxygen for the preheating flame, a considerable amount of oxygen is also required for burning the material and blowing out the slag. This leads to an excess of unused oxygen, the amount of which will increase if the pressure employed is too high, or if the nozzle is too big for the workpiece being cut. It is therefore important to select the correct nozzles and pressures.

## Improper use of oxygen

In addition to the previously mentioned hazards of oxygen enrichment of the air, it is vital to note that UNDER NO CIRCUMSTANCES is oxygen to be used as a replacement for instrument air. Oxygen is an oxidising gas and strongly supports combustion and is UNSUITABLE for the following purposes:

- Driving pneumatic tools.
- Inflating vehicle tyres, rubber boats etc.
- Cooling or freshening the air in confined spaces.
- Cooling the person as air conditioning.
- Dusting benches, machinery and clothing.
- Starting diesel engines.

It should be appreciated that this list is by no means complete.

## Wear the correct clothing

Many so-called non-flammable textile materials will burn fiercely in air containing as little as 30% oxygen, and no material should be considered safe unless it is known to have been subjected to a proper test.

Clothes should be well fitting, yet easy to remove and free from oil and grease.

Persons who have been exposed to an oxygen-enriched atmosphere must not smoke or go near hot spots or sparks until they have properly ventilated their clothes in a normal atmosphere. A ventilation period of a minimum of 5 minutes with movement of the arms and legs and with the coats unbuttoned may be necessary.

When working with flammable gases (acetylene, hydrogen, LPG), only cotton clothing should be worn. Man-made fibres should not be worn as they generate static electricity sparks which can ignite flammable gases.

## Prevent oxygen deficiency in the environment

Oxygen deficiency of the atmosphere is best guarded against by careful attention to the following points.

### Leakage of gases other than oxygen

This leads automatically to oxygen deficiency.

Consideration should be given to the use of atmospheric monitoring in confined spaces.

### Vent outlets

Vented gases are often deficient in oxygen, and work should not be carried out in such atmospheres.

### Welding and heating processes

All gas welding and heating processes involve taking oxygen from the air and can tend to cause an oxygen deficiency unless the volume of workspaces and their ventilation is sufficient.

## Use of gases other than air in closed area

An appropriate risk assessment and/or Permit to Work procedure may be needed.

## Physiological hazards due to oxygen deficiency

Oxygen is essential to life, and it is therefore vital to ensure that adequate oxygen is present in any atmosphere being breathed.

Respiratory complications may occur in an atmosphere containing less than 19.5% oxygen.

A significant feature of oxygen deficiency is that it cannot readily be detected by the senses, and victims are usually unaware of the danger they are in and may even have a feeling of wellbeing.

## Prevent dangerous accumulations of fuel gases

In certain procedures, fuel gases are used along with oxygen. Fuel gases that escape may form ignitable and explosive mixtures with the surrounding air and lead to fires or explosions. The ignition limits of the most common fuel gases when mixed with air are:

Fuel Gases	Upper and Lower Explosive Limits
Acetylene	2.5–85.0 vol %
LPG (e.g. Handigas™)	2.2–9.5 vol %
Hydrogen	4.0–75.0 vol %

The lower limit is particularly important, as this is the one that is reached first. There is less danger that these ignition limits will be reached in large welding shops that have good natural ventilation or are in the open air. Inside containers or in confined spaces however, even small quantities of escaping fuel gas are sufficient under certain conditions to form an ignitable mixture. Fortunately, acetylene can be recognised by its distinctive smell in very small concentrations, well below 2%.

Acetylene/LPG in the air is therefore very easily detected by a good sense of smell, enabling corrective action to be quickly taken.

## LPG (e.g. Handigas™) will accumulate in low-lying areas

Because of its high specific gravity, Handigas™ flows to the ground like a liquid when there is little air movement; thus it may remain for a very long time if there is no way for it to flow away. It is then possible for ignitable concentrations to arise.

## Check hoses and apparatus for leaks

Undesirable mixtures of fuel gas and air are usually the result of leakages, due for example to faulty hoses, missing hose clips on hose connectors or torches, or faulty torches and torch hoses.

## Close valves when apparatus is not in use

In many instances, accidents could have been avoided by closing valves. In some cases, leaky equipment or torches with the fuel gas valve not properly closed have been left in small shops for long intervals and when work was resumed serious accidents have occurred.

## Remove gas equipment from confined spaces when not in use. Beware of fumes being generated.

Gas equipment connected to a supply must not be allowed to remain in confined spaces or vessels during rest intervals or meal breaks, but must be taken out for that time.

Cutting and welding metals by flame or arc processes produces fume. The fume is in two parts.

1. Particulate fume, which is usually visible as smoke, and consists of fine metal oxide powder. The composition of this fume depends upon the metal being cut or welded and in the case of welding, the composition of the filler rod or wire.
2. Gaseous fume, which is not visible and is usually composed of combinations of oxides of carbon or oxides of nitrogen and ozone.

## Ensure that fumes are removed quickly from the work area

The solution to fumes is good local and general ventilation. Local ventilation should be arranged to suck the fume away as it is formed. A number of companies market such units. General ventilation should ensure that the whole atmosphere of the work shop is changed a number of times during a shift.

## Check the properties of filler rods and wires

Some filler rods/wires in welding or brazing may contain particular toxic materials, and the suppliers of these rods or wires should be contacted regarding the hazards and any special fume removal requirement as listed in their respective MSDS's.

## Take special precautions when welding or cutting coated metals

Finally it is most important to take special ventilation precautions when welding or cutting metals that are coated, (e.g. painted, galvanised etc..) because their coatings can produce copious quantities of toxic fumes.

## Noise

Some processes can result in high noise levels. This should be taken into consideration when planning the work and the necessary precautions taken to ensure compliance with current noise legislation.

## Fire

Never underestimate the fire hazard in flame and arc processes particularly as sparks can travel quite an appreciable distance.

1. Where possible work well away from combustible materials such as wood.
2. Remove all materials likely to catch fire.
3. Make sure the floor is swept clear of combustible debris or dust.
4. Work well away from products which give off flammable vapours i.e. paints, thinners, fuels etc.
5. Avoid work on wooden floors or close to wooden roof joists, unless protected by sheet steel or other flame/heat resistant material. Sparks falling through gaps in floorboards are a particular source of danger.
6. Keep fire extinguishers, sand and water available. If necessary douse floor and walls with water before starting work.
7. If you suspect that sparks may have come in contact with wooden structures or entered wall cavities, special visual inspection should be taken after the work has finished. Remember that fire can smoulder for long periods before spontaneous ignition.
8. Always check the work area before leaving, for sparks, smouldering materials etc.

## Working on the welding or cutting of tanks or vessels which may have contained explosive or flammable materials



Do not weld or cut tanks or vessels which may have contained petrol, oils, spirits, paint or any flammable or explosive material without making sure that the vessel contains no trace of the substance or explosive vapours, and has been treated to make it safe for welding and/or cutting.

Before beginning to weld or cut a tank:

1. Remove residue by thorough boiling or steaming immediately before starting.
2. Fill the vessel with water to within an inch or two of the points where the flame is to be applied.
3. If possible vent the enclosed air space.
4. Never blow out the vessel with oxygen.
5. Never approach with naked lights until thorough ventilation has been carried out.
6. Do not use empty oil, petrol or other flammable liquid drums or containers as support for work.
7. Post a warning notice as required.

BOC offers a nitrogen purging service for such tanks or vessels. Contact your local BOC branch for further details.

# Glossary

**AS** — Australian Standard

**Asphyxiate** — to cause reduction of or displacement of oxygen from red blood cells.

**Backflow** — also known as ‘reverse’ flow, where contaminants such as air or moisture enter the cylinder.

**Backstop** — mechanical stop encountered when fully opening a cylinder valve.

**bar** —  $10^6$  dyne/cm<sup>2</sup>,  $10^5$ N/m<sup>2</sup>, 0.98692 atm.

**Bundle** — also known as Pack / Manifolded cylinder pack / MCP.

**Burst disc** — A type of pressure relief device which consists of a disc, usually of metal, which is held so that it confines the pressure of the cylinder under normal conditions. The disc ruptures at a design pressure/temperature range selected for overpressure or in the case of cylinders in fires, to prevent the rupture of the container.

**Cylinder Valve key** — A tool used to open or close cylinders. Applies to cylinders which do not have a handwheel fitted to the cylinder valve, these cylinders are opened and closed by inserting and turning a cylinder valve key (refer to pg 12).

**Flashback** — The return of flame through the blowpipe into the hoses and even the regulators. It may also reach the acetylene cylinder causing heating and explosive decomposition of the contents.

**Flashback arrestor** — The arrestor quenches a flame front (flashback or acetylene decomposition) travelling in a direction opposite to the normal flow. Flashback arrestors often incorporate other safety features which may include non return valves, cut off valve and safety valve.

**Gauge (g)** — suffix to indicate the pressure relative to the local atmospheric pressure, not as an ‘absolute pressure’. Indicated as directly following the usual unit measurement eg barg, psig, kPag.

**Gland nut** — An adjustable nut which when tightened compresses a gland seal to form a leak tight joint between the mating metal surfaces (i.e. in the case of a cylinder valve, the body and stem).

**Non return valve** — A valve which is designed to only allow flow in one direction. The direction is indicated by an arrow on the valve body.

**LDF** — Leak detection fluid, applied to valve and other potential leakage points, to detect leaks e.g. VFV Leak Detector, Teepol HB7.

**MSDS (Material Safety Data Sheet)** — information sheet detailing the following specifics relating to a particular gas:

- Identification of the material and supplier
- Hazards identification
- Composition / information on ingredients
- First aid measures
- Fire fighting measures
- Accidental release measures
- Storage and handling
- Exposure controls / personal protection
- Physical and chemical properties
- Stability and reactivity
- Toxicological information
- Ecological information
- Disposal considerations
- Transport information
- Regulators and other information

**Pack (or Bundle)** — A number of cylinders (usually 4–15) manifolded and palletised together to common outlet(s) (usually 2) and contained within a standard pallet footprint.

**Permanent gas** — A gas that has a critical temperature below  $-10^{\circ}\text{C}$ . (In everyday terms a gas that cannot be liquefied by increasing pressure at ambient temperatures e.g. oxygen, nitrogen, argon).

**POC** — Privately Owned Cylinder

**PPE** — Personal Protective Equipment relates to clothing, footwear, hand, face and hearing protection appropriate when handling and using gases.

**Pressure drop test** — A leak check where the equipment is pressurised to normal working pressure and no pressure drop is observed over 5 minutes. If a pressure drop is observed, this indicates a leak in the assembly.

**Pressure gauge** — A device which indicates pressure.

**Pressure regulator** — A device used to reduce pressure from a higher pressure source such as a gas cylinder to a controllable safer working pressure range.

**TDI** — Test Date Tags are tags fitted to cylinders designed to distort or melt when heat affected to alert BOC of any heat damage to the cylinder.

Pressure cross reference chart

kPa	bar	Millibar(mb)	atms.	kg/cm <sup>3</sup>	psi	mm.Hg	Metres H <sub>2</sub> O at 20°
1	0.010	10.000	0.010	0.010	0.145	7.501	0.102
100.000	1	1000.000	0.987	1.020	14.504	750.063	10.216
0.100	0.001	1	0.001	0.001	0.015	0.750	0.010
101.325	1.013	1013.250	1	1.033	14.696	760.001	10.351
98.067	0.981	980.665	0.968	1	14.223	735.560	10.018
6.895	0.069	68.948	0.068	0.070	1	51.715	0.704
0.133	0.001	1.333	0.001	0.001	0.019	1	0.014
9.789	0.098	97.890	0.097	0.100	1.420	73.424	1

For more information on any BOC products or service contact the **BOC Customer Service Centre** on:

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