



WHS UNIT

# Storage and Handling of Gas Cylinders Guidelines

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## 1 Background

This document provides basic guidance on the safe storage and handling of compressed gas cylinders. These guidelines need to be followed in order to protect people, property and the environment from emergencies involving gas cylinders as well as ensuring compliance with relevant legislation.

## 2 Scope

These guidelines apply to all workers and others who store and handle gas cylinders at the University of Wollongong.

## 3 Definitions

<i>Asphyxiation</i>	Breathing difficulties (suffocation), loss of consciousness and eventual death caused by an inadequate supply of oxygen to the body.
<i>Flammable gas</i>	A gas that can be ignited in air.
<i>Inert or Noble gas</i>	Any of the six gases helium, neon, argon, krypton, xenon, and radon. These gases are un-reactive except under certain special conditions.
<i>Non-flammable gas</i>	A gas that is neither flammable nor poisonous but can still cause asphyxia and death.
<i>Oxidizing gas</i>	A gas that initiates or promotes combustion of materials through release of oxygen. These gases can also spontaneously combust/explode.
<i>Short Term Exposure Limit (STEL)</i>	Maximum concentration of a gas that a person can be exposed to for a 15 minute period. Only 4 such exposure periods can occur within an 8 hour day and 1 hour break is required between exposure intervals.
<i>Time Weighted Exposure Limit (TWA)</i>	Maximum concentration of a gas that a person can be exposed to for 8 hours per day over a 5 day working week.
<i>Toxic gas</i>	A gas that is poisonous or capable of causing injury or death, especially by chemical means.
<i>Upper and Lower Explosive Limits (UEL and LEL)</i>	Upper and lower concentration (in %) limits for which a particular gas is explosive in air.

## 4 Types of Gases

There are three types of gases commonly supplied and used:

1. Compressed Gases – Nitrogen, Oxygen, Air, Carbon Dioxide, Helium
2. Liquefied Gases – LPG, Liquefied Nitrous Oxide
3. Dissolved Gases – Acetylene

Cryogenic vapour could also be considered as a gas but is dealt with in a separate document. Refer to [Storage, Transport and Handling of Cryogenics Guidelines](#) for information on vapour from cryogenics.

## 5 Types of Gas Cylinders

In general, there are three types of gas cylinders:

1. High Pressure Cylinders – High pressure cylinders come in a variety of sizes, see Figure 1. Some examples of gases supplied in High pressure cylinders include Nitrogen, Helium, Hydrogen, Oxygen and Carbon Dioxide.
2. Low Pressure Cylinders – Low pressure cylinders come in a variety of sizes, see Figure 2. Some examples of gases supplied in low pressure cylinder are LPG and refrigerant gases.
3. Acetylene Cylinders – aggregate filled and acetylene is dissolved in acetone to get sufficient product into the cylinder. See Figure 3.

Acetylene is in a class of its own as the cylinder is filled with an aggregate material and dissolved in a liquid medium (acetone).

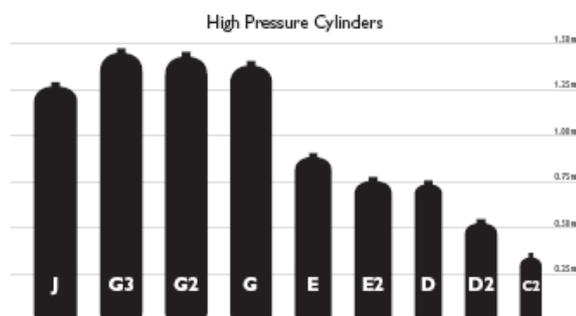


Figure 1: Size range of high pressure gas cylinders available

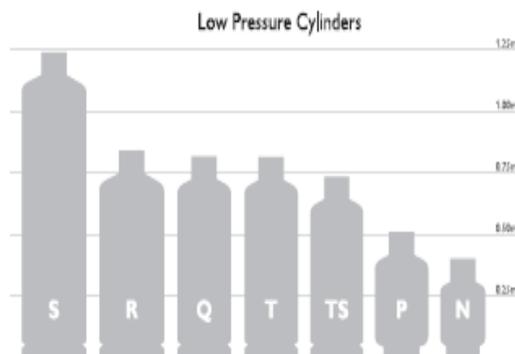


Figure 2 Size Range of low pressure gas cylinders available

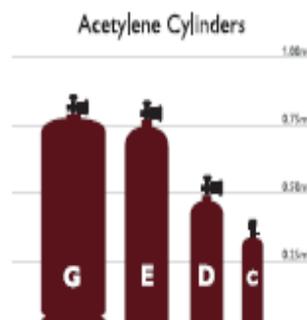


Figure 3 Size Range of Acetylene cylinders Available

## 6 Classes of Gases

The following table shows the four main classes of gases. Gases can also have corrosive properties, eg Ammonia. The class of gas defines its physical properties and transport requirements. However, it is also important for considering storage and handling/usage requirements.

Dangerous Goods Diamond	Class	Examples
	Class 2.1 Flammable gas	LPG, hydrogen, acetylene
	Class 2.2 Non-flammable, non-toxic gases	Compressed air, nitrogen, argon, carbon dioxide, helium.
	Class 2.2, Sub-risk 5.1 Oxidizing gas	Oxygen, nitrous oxide, Entonox (50% oxygen, 50% nitrous oxide).
	Class 2.3 Toxic Gas	Methyl bromide, anhydrous ammonia, chlorine.

## 7 Identification and Labelling

Gas cylinders are required to be labelled with the following:

- Class label and any subsidiary risk labels
- The proper shipping name
- A four digit United Nations number
- Manufacturer/importer's name

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).

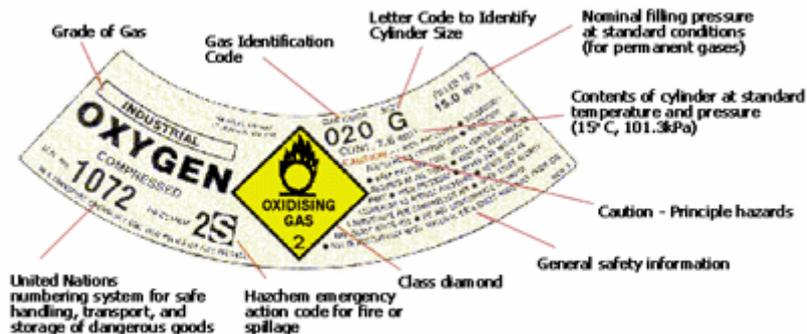


Figure 4 Typical Gas Cylinder Label Information

Protect the markings on cylinders that identify the contents, and mark the full/empty status on cylinders. Manufacturers paint gas cylinders using a colour coded system that is useful for identification. You should consult the manufacturer's product catalogues for colour charts with this information.

**NEVER** alter markings, labelling or colour coding of gas cylinders supplied. They are a rented item and should be treated as such. The integrity and compliance of the gas cylinder is the supplier's responsibility.

**NOTE:** All gas cylinders are also fitted with a barcode by the supplier for tracking purposes. The barcode should not be tampered with or removed. The barcode is scanned by the supplier on supply of the cylinder and also again upon return and identifies who has used the cylinder, the time period it has been used for and the rental charges to be paid by the user. If the barcode is removed or can't be scanned on return to the supplier additional rental charges could be incurred and these could be substantial. Furthermore, if the supplier has no record of the cylinder been returned this could be considered as theft.

## 8 Cylinder Valves and Regulators

### 8.1 Cylinder Valves

The gas cylinder valve is the primary safety mechanism on a gas cylinder and shall not be tampered with. It is a device used to contain the contents of the cylinder that is under pressure. Cylinder valves are fitted with pressure relief valves of different types (depending on the cylinder) to protect against catastrophic failure of the cylinder valve. Figure 5 & Figure 6 show different types of cylinder valves and pressure relief devices respectively.



Figure 5 Examples of Typical Gas Cylinder Valves

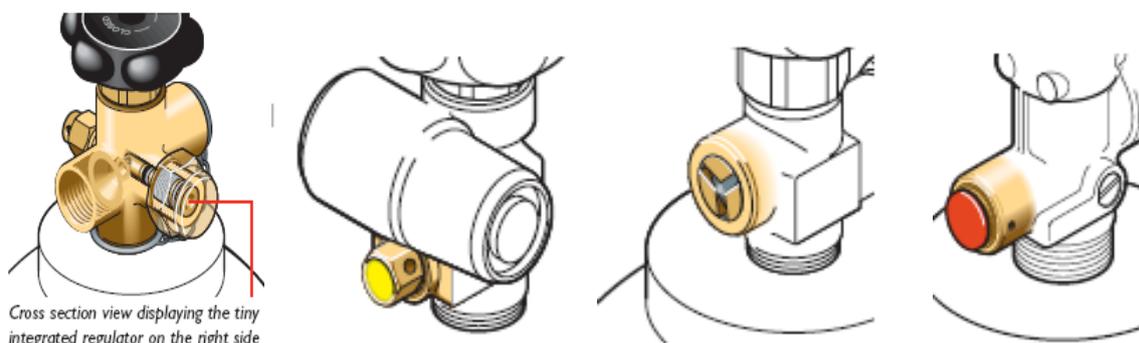


Figure 6 Typical pressure relief devices fitted to cylinder valves. Top Left - Integrated regulator type for 300 atms cylinders, Burst disc type, Fusible plug type, STD pressure relief valve.



**NOTE:**

Cylinder valves on flammable gases have a left hand thread to attach the regulator. This is to distinguish them from non-flammable gases.

The thread size of an Air or Nitrogen cylinder valve differs from Oxygen so that they cannot be mistaken in medical applications.

Cylinder valves open in an anticlockwise direction and close in a clockwise direction. Valves shall never be opened without a regulator attached. Always open cylinder valves slowly. Figure 7 shows the operation of the cylinder valve.

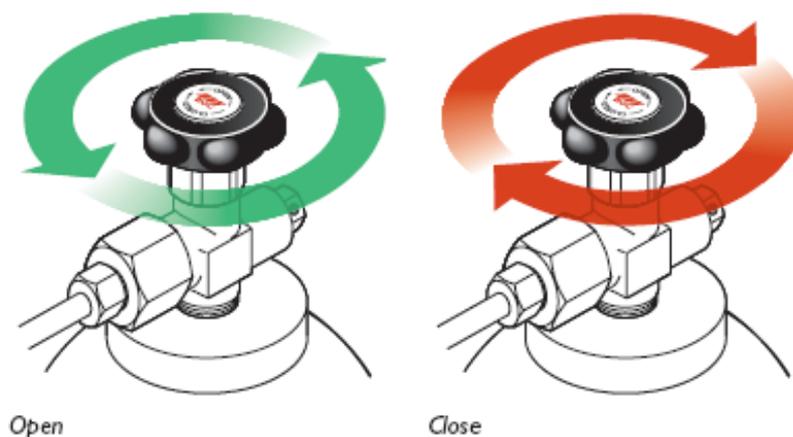


Figure 7 Correct operation of gas cylinder head valve tap

## 8.2 Regulators

The regulator is the next most important safety device to be fitted to a gas cylinder before operation/use. It allows for the high pressure of the cylinder contents to be brought down to a usable working pressure. Regulators come as single stage for short term applications and two stages for long term applications. Regulators are also constructed from different materials, mainly brass or stainless steel.

The application will define the required regulator. If you are unsure of which kind of regulator to use, consult your gas supplier.

Regulators are designed to be fitted directly to the cylinder valve. No other fittings, connections or lubricants shall be used to connect a regulator to a gas cylinder valve.

Regulators for flammable gases are left hand threaded and have a notch cut out of faces on the securing nut to distinguish them from non-flammable gas regulators.

## 9 Risks and Hazards from Gas Cylinders

Gas cylinders can be hazardous due to both their physical (size and weight) and chemical characteristics. Hazards from gases are also subject to the chemical properties of each gas. These may be one or more of the following:

- Fire or explosion from the release of flammable gases near ignition sources (e.g. acetylene or LPG). Refer to SDS for Upper and Lower Explosive Limits (UEL and LEL)
- Spontaneous combustion from oxidizing gases (e.g. oxygen or nitrous oxide)
- Exposure limits for all gases, especially toxic or corrosive gases (e.g. anhydrous ammonia); refer to SDS for Time Weighted Exposure Limit (TWA) and Short Term Exposure Limit (STEL)
- Asphyxiation from non-toxic, non-flammable gases by displacement of oxygen (e.g. nitrogen, carbon dioxide or argon)
- Incorrect storage
- Leaks
- Faulty equipment/connections

- Physical risks
- Manual handling
- Sudden release of gas if cylinder is damaged (torpedo effect).
- Pressure – compressed gas cylinders are filled to a pressure of 200-300 atmospheres
- Gas Density

Read, understand, and follow the markings on the cylinder, the label(s) on the cylinder, and the safety data sheet (SDS) to avoid misuse. The SDS must be read to identify:

- Chemical and physical hazards for each gas cylinder
- Appropriate safe storage and handling practices
- The need for additional control measures
- First aid measures
- Fire-fighting and emergency information
- Density of the gas
- Exposure limits
- Flammability/explosiveness
- Transport requirements

Each compressed gas cylinder has unique hazards based on its contents. Some are filled with inert gases – especially those used in arc welding. Many gases are flammable, explosive, toxic, or a combination.



**NOTE:** When gases are released and expand, a drop in temperature occurs. In some cases (e.g. carbon dioxide) the rapid release and expansion of gas can cause a cold hazard (e.g. frostbite) to exposed persons.

## 10 Hazard Management

The below information outlines controls to be implemented for pre-identified hazards relating to gas cylinders. If further hazards are identified (e.g. local hazards) then a risk assessment must be carried out and recorded to identify hazards and the need for any additional control measures. Safe Work Procedures shall be developed for tasks that routinely involve the use and handling of gases from pressurised cylinders.

Anyone working with gas cylinders needs to be given information, training and effective supervision regarding the hazards from gas cylinders, safe storage and handling information and what to do in an emergency.

### 10.1 Storing Cylinders

#### 10.1.1 Bulk Cylinder Storage

Gas stores should be located outdoors, preferably in a secure, cage protected from sunlight. Storage indoors is not recommended unless the building has been designed for that purpose with appropriate fire rated walls and ventilation. Where gases are stored indoors, additional safety considerations and control measures need to be given consideration.

It is recommended that if you store significant quantities of gas in cylinders that you consult AS 4332 - *The Storage and Handling of Gases in Cylinders* for guidance, or consider the services of a dangerous goods consultant.



Figure 8 Example of a bulk storage location for cylinders at UOW Wollongong Campus

### 10.1.2 Laboratory Specific Storage Requirements – Cylinders in Use

Store cylinders in an upright position<sup>1</sup>. If cylinders have been lying on their side, place the cylinder in the upright position and wait 60 minutes before using. If Acetylene has been laid on its side, then it is recommended that the cylinder is not used for 12-24 hours.

Secure cylinders using a purpose built non-abrasive coated chain, strap or cable that will not scratch the cylinder markings and paint work or a racking system. Refer Figure 9.

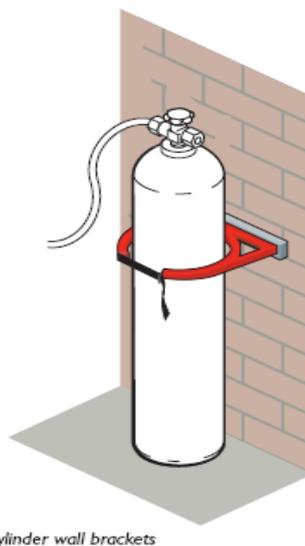


Figure 9 Cylinder secured by wall brackets

Completely close the valves, and keep the valve protection devices, such as caps or guards, securely in place when cylinder is not in use.

- Store cylinders in a dry, well-ventilated area.
- Place them in a location where they will not be subject to mechanical or physical damage, heat, or electrical circuits to prevent possible explosion or fire. Keep cylinders away from pedestrian traffic.
- Full and empty cylinders should be stored separately in clearly marked areas.
- Objects should not be stored on top of gas cylinders.

<sup>1</sup> Some cylinders are designed to be stored on their side. Consult the SDS or contact the supplier for additional information.

- Gases denser than air need to be stored with caution to avoid storage where these gases can collect in low lying areas.
- Gas cylinders should not be located where they may block stairs, exits, ladders or walk ways.
- Ensure an up to date and accurate inventory is kept. Keep inventory quantities as low as possible.
- Avoid storing cylinders below 0°C. Some mixtures may separate below this.
- Laboratory storage locations should be positioned as close to the usage point as possible.

### 10.1.3 Segregate Incompatible Gases and Dangerous Goods

Corrosive liquids can damage gas cylinders on contact. Flammable liquids can spread a fire across a workplace floor and allow flames to come into contact with gas cylinders. Other dangerous goods may also be adversely affected by gas cylinders in an emergency. For this reason, gas cylinders are kept separately from other dangerous goods and combustible liquids by at least 5m or by using appropriate fire rated barriers. Segregation of incompatible goods also allows fire fighters to safely use appropriate fire-fighting media for each type of goods present.

Gas cylinders must also be segregated from other incompatible gases by at least 3 m. The following is recommended:

- Class 2.3 “Toxic gas” and corrosive gases (subsidiary risk of Class 8 “Corrosive”) are stored away from all other gas cylinders.
- Class 2.1 “Flammable gas” shall not be stored with subsidiary risk class 5.1 gases or oxygen.
- Keep oxygen cylinders five metres away from other dangerous goods (e.g. Class 3, 4, 5, 6.1, 7, 8 or 9, etc) and combustible liquids (e.g. diesel fuel, acetylene), or separate them with a non-combustible barrier (such as a wall) at least one metre higher than the tallest cylinder with a fire-resistance rating of at least half an hour.
- Ensure gas cylinders are stored at least three metres away from combustible materials and debris (e.g. timber, card board, packaging materials) to prevent flame impingement on gas cylinders in a fire.

Mutually compatible gases (e.g. Class 2.2, without subsidiary risk) may be placed between incompatible gases.

### 10.1.4 Heat and Ignition Sources

Heating of the cylinder (e.g. from fire) or impact to the pressure vessel wall may result in explosion and shrapnel hazard to exposed persons.

- DO NOT use oil or grease on the valve of a cylinders or regulators/gauges, particularly those containing oxygen or oxidising agents, to avoid fire or explosion.
- Store cylinders in cool areas away from sources of radiant heat (e.g. boilers, hot surfaces, and internal combustion engines). Where possible, store cylinders in the shade to avoid exposing cylinders to direct sunlight.
- Cylinders containing flammable gas should not be stored near sources of ignition such as naked lights / flames, cigarette smokers, etc.
- For flammable gas storage, appropriate signs stating “No Smoking”, “No Naked Lights” should be erected to preclude ignition sources from these areas.

All gas cylinders should be fitted with a test tag that is heat sensitive. **DO NOT** use a cylinder if the test tag is missing or shows evidence of heat exposure.



Figure 10 Normal and heat effected test tags

## 10.2 Safe Handling Practices

Most accidents or injuries involving cylinders happen when moving or handling the gas cylinders. Large gas cylinders (e.g. G or F sized cylinders) can be bulky, heavy, and awkward to handle, they require special care and equipment in handling and securing so they don't fall or tip over and cause injury.

Anyone involved in the handling of gas cylinders should undertake some basic induction training or have read the Safe Work Procedures relating to the transport, storage and use of Gas Cylinders. Wear protective footwear, safety glasses. Gloves are also recommended.

Securely install the valve protection devices when the cylinder is not in use, such as caps or guards. **EXEMPTION: G size cylinders will not have a protective cap or guard fitted.**

When moving cylinders, **DO NOT** roll or drag them. Ensure that an appropriate mechanical handling device is used (Figure 11). Secure cylinders upright to a proper hand truck or cylinder cart with a restraining strap designed for the purpose. Cylinder size E and greater shall be handled using mechanical assistance.



Figure 11 Mechanical handling devices

Contact your gas supplier if more sophisticated handling of cylinders is required.

**DO NOT** lift by the protective cap. If a cylinder does not have a handle then use mechanical assistance to move it.

**DO NOT** restrain cylinders around their necks or valve – restrain them around the main cylinder body at a height that will prevent them from falling over, i.e. 1/2 to 2/3 the height of the cylinder. Avoid dropping or knocking cylinders about. Prevent damage to cylinders from impact from other objects (e.g. crashing into other cylinders). Some cylinders (e.g. acetylene) may react violently after being excessively shaken, heated, or knocked.

Cylinders should **NEVER** be used as rollers to move other objects.

## 10.3 Using Gas Cylinders

- Always use gas cylinders in well ventilated areas. **DO NOT** use gas cylinders in confined spaces unless qualified to do so and the appropriate PPE is used.
- Know the gas you are using and possible reaction products. Additional mechanical ventilation may be required. Seek expert assistance in designing and installing mechanical ventilation systems.
- Ensure the correct regulator is used for the purpose.
- Ensure there is a suitable emergency response procedure in place.
- Wear appropriate PPE for the gas been used, refer to SDS.
- Ensure connections, fittings and lines are leak tight and suitable for use.
- Ensure that flammable and oxidising gases are not used near ignition sources.
- Disconnect empty cylinders from equipment to avoid backflow issues
- Always close the cylinder valve when not in use.
- **DO NOT** use an empty cylinder as a waste receptacle.
- Fit non-return valves in line if required
- **DO NOT** use a gas cylinder that shows evidence of damage or corrosion. The gas cylinder is a rented item; its integrity is the responsibility of the gas supplier.
- If the cylinder contents cannot be clearly identified, **DO NOT** use it. Return it to the supplier.



**NOTE:** If a cylinder shows frosting around the valve than the flow through the system is too high or there is a significant leak in the system. If a high flow rate option is required, consult your gas supplier for the best solution. For information on handling leaks refer to section 12.2.

## 10.4 Manifest of Hazardous Chemicals

Requirements for management of placarding and manifest quantities of hazardous chemicals (including gas cylinders) is outlined in the [Dangerous Goods Storage and Handling Guidelines](#). This includes a list of storage areas (including contents and quantities), site plan, emergency plan for Fire & Rescue NSW, and notification to SafeWork NSW.

# 11 Transporting Gas Cylinders

## 11.1 Transport within Buildings

Cylinders shall be transported within buildings according to section 10.2.

Transporting cylinders between floors of a building shall be done in the lift alone. No person is to travel in the lift with the gas cylinder. The cylinder trolley shall be secured to the lift hand rail to prevent it from falling over. Ideally a sign should be used across the entrance of the lift to prevent others entering the lift while the cylinder is in transit.

Secure the cylinder immediately once arriving at the usage location.

## 11.2 Transport with Vehicles

Gas cylinders used in the field may require the use of a vehicle to get them to the field site. Where possible, have your gas supplier deliver the cylinders directly to the field site. If a vehicle is required to transport cylinders, then it shall be done as follows:

Gas cylinders shall only be transported on an open back utility OR in a utility back canopy that is separate from the main body of the vehicle.

Ideally cylinders should be transported standing up and firmly secured. Flammable and Liquid withdrawal cylinders should always be transported in upright position.

If cylinders are transported lying down than suitable support devices are required to prevent the cylinders from rolling. Also settling time will be required for the cylinder before use, refer to section 10.1.2.

Remove the gas cylinder(s) from the vehicle immediately on arrival to destination and secure them appropriately.

**DO NOT** carry gas cylinders of any kind in the passenger compartment of a vehicle.

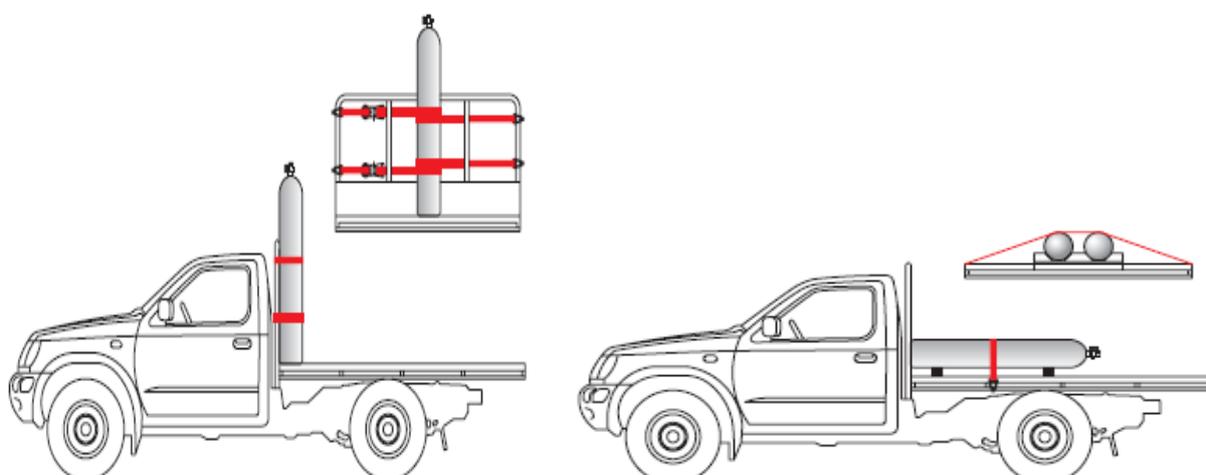


Figure 12 Correct transport requirements for transporting gas cylinders on the back of a utility

## 12 Troubleshooting

### 12.1 Cylinders in a Fire

If a cylinder has caught on fire OR is in close proximity to a fire than the following actions shall be taken:

- Evacuate the area 100m around the fire
- Inform those within 100-300m from the fire that a gas cylinder is involved in the fire
- Call the fire brigade and inform them of the fires location and gas(es) involved.
- Inform your gas supplier of the incident as the cylinder integrity will have been compromised.
- **DO NOT** attempt to fight the fire under any circumstances. Leave it to the professionals.

### 12.2 Leaks

Leaks from gas cylinders are potentially very dangerous, depending on the properties of the gas. If a gas cylinder is found to be leaking than appropriate measures should be put in place to limit risk.

If a flammable gas is found to be leaking then it should be treated as if the cylinder were on fire, Refer 12.1.

Non-flammable, non-toxic gases found to be leaking from a cylinder should be removed to a well ventilated outdoor location to degas.

Leaking toxic gases are extremely dangerous. Immediately evacuate the area and follow the normal school/faculty emergency response procedures. The fire brigade shall be called and informed of the type of leaking gas. **DO NOT** re-enter the area until it is deemed safe to do so by professionals.

**NOTE:** Where toxic gases are used suitable gas detection devices should be installed and a gas mask rated to the gas in question available. Gas detection devices are also recommended when storage and use of gas cylinders in poorly ventilated areas is unavoidable.

Test for leaks with a squeeze bottle of soapy water. Bubbles form at the point of gas escape. Leak detection devices are also available for determining the location of a leak.

## 13 Cylinder Safety

Below is a summary of the **DO's/DON'Ts** when working with gas cylinders

DO	DON'T
Ensure a regulator is fitted before use	Repaint a cylinder
Ensure cylinder is firmly secured	Change the markings on a cylinder
Ensure connections are tight and suitable	Use oil or lubricants on cylinder valve
Ensure cylinders are stored and used away from ignition sources	Tamper with the gas cylinder test tag
Store full and empty cylinders separately	Tamper with or remove the barcode from a gas cylinder
Ensure valve guards or caps are fitted when cylinders are not in use	Roll cylinders along the ground
Use mechanical assistance when handling cylinders	Attempt to fight a fire involving a gas cylinder
Ensure adequate ventilation is available for the gas in question	Transport gas cylinders in the passenger compartment of a vehicle
Ensure exposure limits are not exceeded	Use a cylinder that shows evidence of damage or corrosion
Read the SDS	Fill cylinders with any material at all
Follow appropriate SWP	
Have gas detection devices installed if required	

## 14 Related Documents and References

- Refer to **AS 1596-2008 The storage and handling of LP Gas** for requirements and recommendations for the safe storage and handling of LP Gas, in cylinders and bulk tanks.
- Refer to **AS 2243.6-2010 Safety in laboratories Part 6: Plant and equipment aspects** for more detailed guidance on safe handling and use of compressed gases, and specific precautions for Oxygen, Acetylene, Hydrogen, compressed air and liquefied and dissolved gases.
- Refer to **AS 2243.10-2004 Safety in laboratories Part 10: Storage of chemicals** for more detailed guidance on the safe storage of gas cylinders used in laboratories.
- Refer to **AS 4332-2004 The storage and handling of gases in cylinders** for more detailed guidance on location and construction of gas cylinder stores, including ventilation; operational and personal safety; and fire protection and other emergency measures.
- Refer to **AS 60079.10.1-2009 Explosive atmospheres - Classification of areas - Explosive gas atmospheres** for more detailed information about protective measures to reduce the risk of explosions.
- SafeWork NSW - Dangerous Goods – website <http://www.safework.nsw.gov.au>
- Guidelines for Gas Cylinder Safety, BOC Gases
- Safe Work Australia – Hazardous Substances Information System

## 15 Version Control Table

Version Control	Date Released	Approved By	Amendment
1	November 2012	Manager WHS	New document
2	December 2015	Manager WHS	Scheduled review – no significant changes