STOREMASTA®

Gas Cylinder Storage : Compliance and Safety Requirements

Contents

Gas Cylinder Storage: Compliance and Safety Requirements

In Australia, if your workplace contains gas cylinders (even empty ones) they must be stored in compliance with AS 4332—2004 The storage and handling of gases in cylinders. This eBook presents the requirements of the Australian Standard in an easy-to-read format to help you understand;

- The workplace hazards associated with storing gas cylinders
- Your legal obligations according to the Australian Standard and Dangerous Goods Code of Practice
- How to manage and control risks when storing gas cylinders at your workplace.

Our eBook contains real world examples of workplace incidents and accidents involving gas cylinders, as well as hypothetical scenarios to illustrate the risk management process. More specifically we outline;

- The best location for your gas cylinder storage area
- How to segregate incompatible gases of different hazard classes
- How to create a gas cylinder storage area using gas bottle cages and safety cabinets
- Tips for handling gas cylinders safely

This eBook is an excellent resource for WHS Managers needing clear and actionable advice for managing the risks associated with storing gas cylinders. But remember, every workplace is different so the layout of your worksite (as well as the way your gases are used and stored) will present a unique set of risks and hazards. Always conduct a full risk assessment of the gases and cylinders used and stored at your own workplace and if you need help, get in contact with us today.

1. Location

How to find the best place for your gas cylinder stores

Before you install your gas cylinder stores you need to identify the safest and most practical area onsite. While stores can be either inside or outside, outdoor storage areas are best practice, and recommended by the Standard.

Indoor gas cylinder storage should always be avoided.

Some of the biggest risks when storing compressed gases in cylinders are leaks, and this is the key reason why indoor storage of gas cylinders should be avoided wherever possible. If a gas leak occurs outdoors, in many instances the gas will be dispersed safely. But indoors, a whole room or building can quickly fill with gas.

When gas like LPG — which is highly flammable and denser than air — collects in low areas instead of dissipating, accumulated gas remains in its explosive range.

REAL WORLD EXAMPLE: a small gas BBQ stored indoors caused a major explosion at a construction site. Luckily no one was killed.

Workers at a construction site liked to use a small gas BBQ to cook their morning smoko and lunches. At the end of the day the BBQ and its cylinder were stored inside a shipping container — next to a soft drink vending machine. One afternoon when the BBQ was stored away, the LPG cylinder valve was left open. Additionally (maybe while moving the BBQ) one of the heating control knobs was left open too.

Overnight the shipping container (lacking adequate ventilation) began to fill with LPG, this was not detected by a worker who opened the shipping container the next day. A short time later, static electricity from a thermostat in the drink vending machine ignited the leaked gas and caused an explosion. The shipping container and contents was destroyed, the 100kg door was propelled hundreds of metres, a worker was injured, plus neighbouring buildings and cars were significantly damaged.

The above example demonstrates the explosive potential of flammable gases and the dangers of storing gas cylinders indoors -- even gases containing odorants are not always discernible on an industrial worksite. It is critically important to turn off valves and disconnect attachments when gas cylinders are in storage.

REMEMBER: an outdoor store must be free standing and have at least 40% of its walled areas fully open. Shipping containers (which are designed to be sealed and have only limited ventilation) are NOT considered outdoor stores and cannot not be used to store gas cylinders of any type.

Outdoor gas cylinder stores are best practice

Storing gas cylinders outdoors is always best and according to the Standard, an outdoor storage area is free standing with the following essential specifications:

Base:

The store must be at ground level, and any space between the cylinders and the ground filled with a solid base.

Traffic:

Where possible locate storage areas away from traffic and machinery. If this is not possible then bollards or crash barriers must be installed to minimise the risk of cylinders being hit by vehicles.

Level:

The base of the cylinder store should be level (and possibly sloped to allow for drainage) and constructed from non-combustible materials. The base materials must be sturdy and able to withstand all weather conditions without becoming indented or damaged.

Heat:

Cylinder stores must not be close to artificial sources of heat — so away from radiators, boilers, steam pipes etc.

Security:

Untrained staff and other unauthorised personnel must not be able to access cylinder stores. Make sure the storage area is fenced and secure.

TIP: Use a robust gas bottle cage made from heavy duty sheet metal materials, complete with bump rails and a tamper-proof locking system.

2. Segregation

How to safely segregate and separate incompatible gases

Like all hazardous chemicals, compressed gases must be segregated and separated according to their gas and hazard class. Segregation is about isolating incompatible gases from one another, whereas separation is about physically separating the gas cylinder stores away from site machinery and operations; pedestrians and traffic; other dangerous goods and hazardous chemicals.

In the Standard, the following gases must be segregated by at least 3 metres:

- Class 2.1 flammable gases (acetylene, LPG)
- Class 2.2 (5.1) non-flammable, oxidizing gases (oxygen)
- Class 2.3 toxic gases (chlorine)

Screen walls can also be used to achieve segregation distance and clear diagrams as well as detailed tables are provided in the standard. The 3 metre segregation rule also applies to combustible materials, refuse and vegetation.

NOTE: Segregation distances can vary according to the hazard class of each gas plus the quantities being used and stored at your worksite.

REAL WORLD EXAMPLE: a gas cylinder exploded killing a worker who was walking past the storage area.

When a worker was walking post a gas cylinder storage area, one of the bottles exploded. He died after suffering horrific injuries including burns, lacerations, fractures and loss of limbs.

While it is unknown what caused the gas bottle to explode, this tragic accident does demonstrate the importance of properly segregating and separating gas cylinder stores. An exploding gas cylinder able to reach other stores of toxic or flammable gas cylinders would be catastrophic.

3. Storage

How to safely store gases in cylinders

Gas cylinders should always be stored upright in a secure safety cage and restrained by chains or safety straps. Valves must be closed, attachments removed, and safety caps in place. The Standard also requires that ...

- Copies of safety data sheets (SDSs) for each of the gases (plus first aid equipment) are nearby.
- Gas stores are NO SMOKING areas.
- Entry points and emergency exits are kept clear at all times.
- Adequate ventilation should maintain safe oxygen levels at all times, as well as safe gas exposure standards and within explosive limits.

Like all storage areas for Dangerous Goods, cylinder stores must also have correct signage. This includes safety labels, hazard statements, and placards.

NOTE: if natural ventilation is not possible, a mechanical ventilation system must be installed. This would include exhaust fans, ducting and monitoring controls.

REAL WORLD EXAMPLE: a contractor was killed, and 6 more seriously injured when 66 unrestrained gas cylinders began to literally fly about a storeroom. They were each 2 metres high, weighed at least 140 kg, and were flying at speeds of more than 273 kilometres per hour.

At a construction site in the UK, 66 cylinders of an inert gas called argonite were placed in a storeroom temporarily; they were intended for the new building's fire protection system. They were not restrained with chains or in a cage, and did not have safety caps placed over their valves. Additionally, there was no safety signage or placards in or around the storeroom to alert workers and contractors that gas cylinders were inside.

When one of the cylinders fell over and its cylinder neck was immediately shorn off, the high pressure gas began to shoot out, causing a collision with another cylinder. This escalated into a terrible domino type-effect, where 66 cylinders each fell over, had their necks broken off and were propelled about the storeroom almost like torpedos.

Sadly a plumber and 6 other contractors (who had received no safety briefing or indication that gas cylinders were inside the storeroom) entered the area. They were all critically injured and the plumber died at the construction site.

While this terrible accident is a clear reminder of the human cost of workplace accidents involving gas cylinders, we haven't mentioned the damage to the building and equipment, loss of trade and production time, plus the hefty fines and court costs imposed by safety authorities. Non-compliance is not only dangerous, it's expensive.

4. Handling

How to safely hand gas cylinders in the workplace

Gas cylinders are bulky and awkward so they create a significant manual handling risk. Not only are they heavy, but their slim design makes them unstable when standing. Australian Standard AS 4332—2004 is very clear about handling gas cylinders and specifies the following:

- Always make sure the valves are closed and cylinder caps in place.
- Never apply excessive force to cylinder valves — so don't lift or carry a gas cylinder using their valves, shrouds or caps.
- Always use a trolley or lifting device (like a forklift) for moving cylinders.
- Because a cylinder must always be protected from being knocked over, falling, or impact damage to the valve; make sure the trolley or lifting device has secure restraints and safety straps.
- Don't drop or roll cylinders over the side of trucks (again use a forklift or other lifting device).

Additionally, you should ensure that your staff are trained to:

- Not transfer or store cylinders with attachments (like welding torches) in place.
- Take care not to trap their fingers between cylinders.
- Use PPE like gloves and safety shoes (many workers have had their toes crushed from dropped cylinders).
- Never try to catch a falling gas cylinder — let the cylinder drop and get out of the way.
- Approach a fallen cylinder with caution, making sure that valves are intact and not leaking.

REMEMBER: The Standard is clear that gas cylinders must never be used for any purposes other than those for which they were designed. Everyone's safety is compromised when somebody straps a cylinder to a go-cart or shopping trolley, or tries to launch a cylinder in the air. Secure your cylinder stores so untrained staff and contractors (particularly young workers) can't mess with your gas cylinders.

REAL WORLD EXAMPLE: a worker suffered multiple fractures to his leg during an accident while moving an oxygen cylinder from the street to a location where he was working.

A worker needed to move an oxygen cylinder from a crowded street to his worksite. According to his supervisor, the heavy tank was meant to be only moved with a forklift, but because the street was so crowded with trucks and other parked vehicles the worker decided to use a trolley instead.

Two workers attempted to manoeuvre the heavy cylinder on the trolley until one of the wheels became stuck in a depression in the road. Using force to release the wheel, the trolley began to tip and both the cylinder and trolley crashed into the employee's leg, causing serious injury. He received multiple fractures and was hospitalised.

While this accident indicates some of the consequences of incorrect handling methods, it also reminds us of the importance of ongoing staff training and supervision. Administrative controls and operating procedures don't always anticipate unique situations (in this case a crowded street making forklift use impossible) so staff need to understand the real dangers to their safety and know to consult managers or supervisors before deviating from safety instructions.

REMEMBER: The standard requires that all staff handling gas cylinders know the properties of the specific gases they are handling as well as safe handling procedures.

Empty Cylinders

According to the Standard, empty cylinders must be afforded the same precautions as full cylinders. Make sure they are used, stored and handled in the same manner as if they were full — this includes being properly segregated and separated.

What this effectively means for your workplace, is you need additional cylinder stores for your empties. Because (just as if it were full) you cannot store an empty O2 cylinder with empty LPG cylinders.

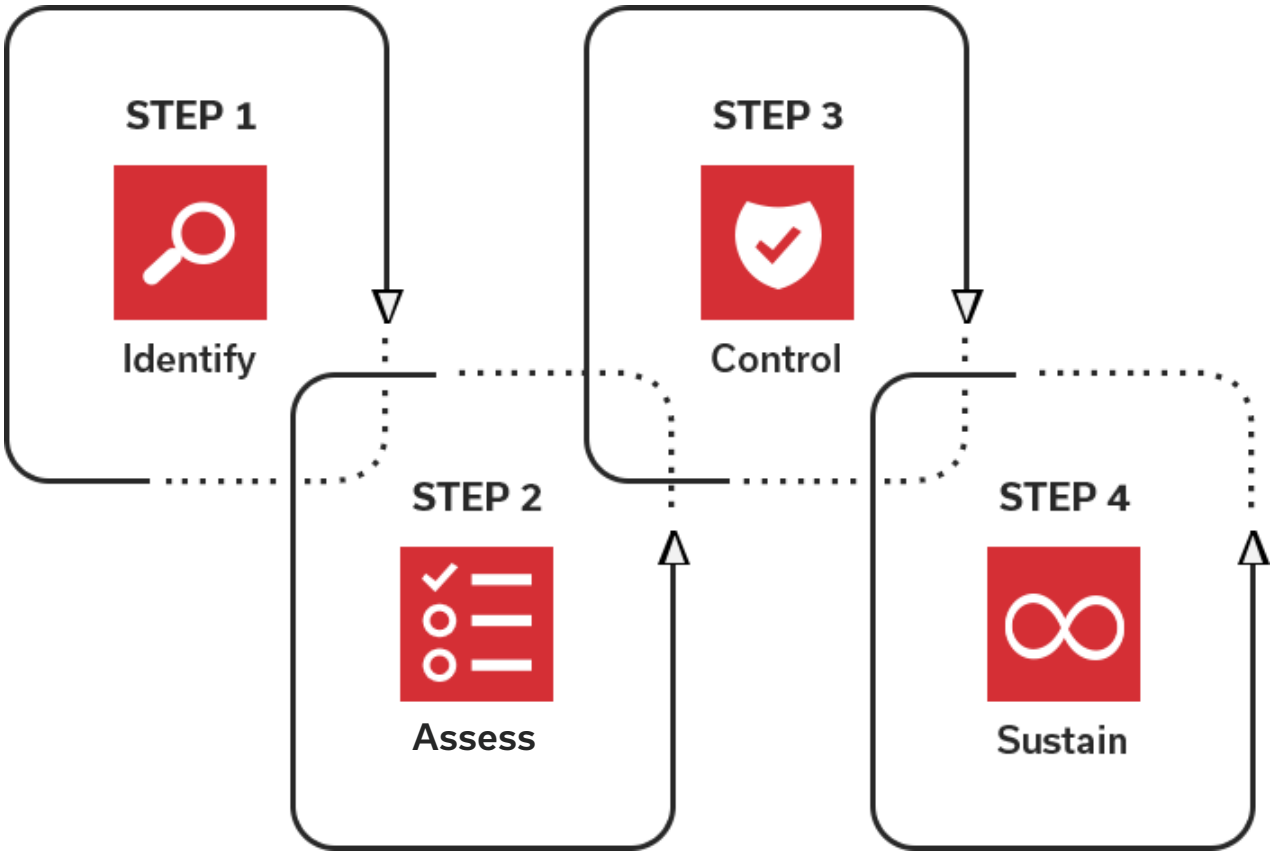
REMEMBER: You must minimise the number of empty cylinders onsite, as the Standard imposes restrictions on specific gas cylinders types. Developing a good working relationship with your supplier is critical to complying with the Standard.

5. Risk Management

How to manage the risks associated with gases in cylinders

In this last section we're sharing the STOREMASTA methodology for Risk Management that can be used to control the hazards associated with the gas cylinders at your worksite.

Our easy to follow methodology is a four step process, and each step should be completed in the following sequence:



Let's look at each step in detail now, so you can apply the methodology to your own workplace.

STEP 1: Identify

The first, and arguably the most important step in our risk management methodology is identifying every gas cylinder you use, store or handle at your worksite; plus the hazards associated with all of them.

Though this might seem a little overwhelming at first, the best way to get started is to conduct a full site check by walking around and physically identifying each cylinder store. If your worksite is large and complex you might need to talk to departmental managers, production supervisors and maintenance staff. A sitemap and floor plan will also be useful.

As you walk around check the label on the cylinders and refer to the Safety Data Sheets (SDSs) provided by the gas supplier; now make a list noting the gas and cylinder type, tank size, quantity and where they are stored or handled.

Your initial list might look something like this:

Gas	Storage Location	Tank Size	Qty	Details
LPG	Outside warehouse	R	12	**Details:** Rotating stock of 12 x tanks for the 3 forklifts. 3 in use plus 3 x spares. Stocks kept in a dedicated Gas Cylinder Store. **Concerns:** one of the safety straps is faulty and the store does not lock. There are a lot of cylinders in stock and sometimes empties are stored with the full tanks until the supplier arrives.

Gas	Storage Location	Tank Size	Qty	Details
Acetylene	Industrial workshop	G	2	**Details:** 2 x acetylene cylinders for welding on trolleys in the industrial workshop. **Concerns:** cylinders are more than 50kg each and difficult to manoeuvre. Cylinders stored with the welding torch attached. First aid station with defibrillator and emergency O2 located in the workshop.

Note: when identifying the hazards associated with gas cylinders, you should also list the health hazards associated with the gases as well as the physical hazards imposed by the cylinders and the fact that the gas is compressed at high pressure.

STEP 2: Assess

Once you have a master list of gas cylinders and their locations (plus an SDS for each of them) you can begin your risk assessment. This risk assessment will look more closely at the each of the hazards you identified, and include concerns about work practices, hazardous events that could occur (explosions, gas leaks), how often those events might occur, and the possible outcomes.

Your risk assessment might begin like this:

Gas	Acetylene
Hazards	Extremely Flammable. Self-reactive and explosive. G size cylinders heavy and bulky.
Locations	Industrial Workshop
Concerns	1. Cylinders are more than 50 kg each and difficult to manoeuvre. 2. Cylinders stored with the welding torch attached. 3. First aid station with defibrillator and emergency O2 located in the workshop.
Hazardous Events	1. Cylinder is dropped or knocked over. 2. Welding torch keeps cylinder valve open and susceptible to ignition by static electricity or O2. 3. Ignition by static electricity from defib machine or contact with O2.
Possible Frequency	1. Daily 2. Daily 3. Once per year

Likely Outcomes	1. The fallen cylinder could potentially explode and cause a CATASTROPHIC event (major fire, death, injuries). 2. Ignited acetylene will quickly decompose and explode resulting in a CATASTROPHIC event (major fire, death, injuries). Any staff in the immediate area are at high risk of death or serious injury, as well as the fire damage to the industrial workshop. 3. Ignited acetylene will quickly decompose and explode resulting in a CATASTROPHIC event (major fire, death, injuries). Any staff in the immediate area are at high risk of death or serious injury, as well as the fire damage to the industrial workshop.

An important part of the risk assessment process is prioritising the hazards that need to be controlled first. To do this you will need to calculate the level of risk by giving a 'risk score' to each hazard.

The risk score is a combination of the consequences of a hazardous event PLUS how likely is it to occur. Give each of these a score out of 5, then multiply them together (see table below).

Consequences	Deaths, injuries, structural and property damage, environmental impacts.	Score from 1-5 (5 being the worst)
Likelihood	Look at how often a cylinder is used, how many people access cylinder stores, and the dangers of the gas itself.	Score from 1-5 (5 being something that could occur every day)

Each hazard is ultimately given a risk score out of 25, then the risks with the highest scores are flagged for immediate attention.

STEP 3: Control

In Step 3 we use the Hierarchy of Control to implement control measures to reduce (or even eliminate) the harm associated with each of the cylinder hazards. Priority is given to the hazards with the highest risk score identified by the risk assessment in Step 2.

The Hierarchy of Control refers to 5 different approaches you must apply to each cylinder hazard. They must be completed in the following order.

1. Elimination (could you stop using the gas/cylinder type?)
2. Substitution (could you use another gas or cylinder type that is less harmful?)
3. Engineering controls (could you design the workplace to reduce the amount of employees who are exposed to the gas cylinders?)
4. Administrative controls (can you create safe operating procedures?)
5. Personal Protective equipment (what protective equipment can be used to protect workers from the gas cylinders?)

Thinking about the examples of the acetylene gas in Step 2, we've identified some hazard control measures (below) using each of the 5 approaches in the Hierarchy of Control. Eliminating the hazard is always the best control measure, but not always practicable.

1. Elimination (have all metals welded by an offsite contractors)

2. Substitution (switch to propane gas)

3. Engineering controls (Design and manufacture a compliant gas cylinder store that will prevent the cylinders from being knocked over.)

4. Administrative controls (ensure cylinders are stored with welding torches removed and safety caps in place)

5. Personal Protective equipment (have all workers wear full-face helmets and fire proof clothing)

The control measures you choose will always be affected by your budget and the practicalities of the worksite location. To be 100% compliant with safety legislation, AS 4332—2004, and the Dangerous Goods Code, you'll need to implement control measures for every health hazard related to the gases as well as every physical hazard related to the cylinders.

REMEMBER: Sometimes control measures introduce new hazards.

STEP 4: Sustain

The final step in our methodology is to periodically review your risk assessment and control measures. To sustain compliance and cylinder safety, you need to ensure that ...

- No new hazards were created through your control measures
- Any changes to SDSs by the manufacturers are reviewed
- Alterations to the worksite or even the sizes of gas bottles are assessed
- New gases introduced to the workplace are controlled

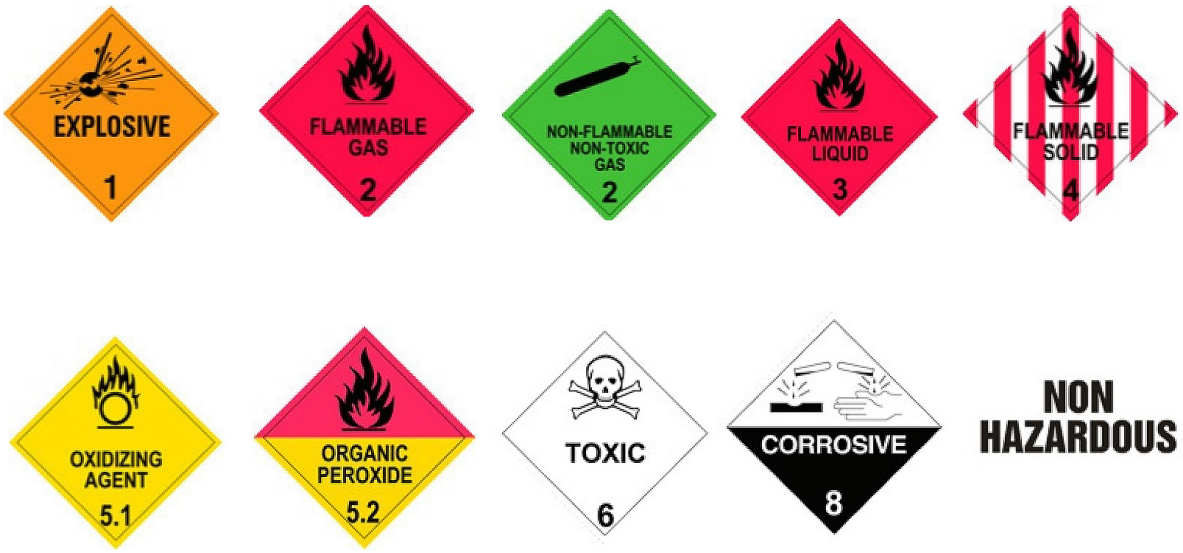
The STOREMASTA risk management methodology helps you develop a system to regularly audit your WHS control measures and test your overall compliance to legislation and Australian Standards. A half yearly or annual external assessment is always recommended to ensure that your gas cylinder stores remain compliant.

REMEMBER: the STOREMASTA methodology for risk management consists of four essential steps. 100% compliance with Australian WHS legislation cannot be guaranteed unless all four steps are undertaken in order, and in full.

6. What's Next

Here at STOREMASTA we are specialists in Dangerous Goods risk management and committed to helping make your workplace safe, efficient and compliant. We are now servicing every industry sector and Government department within Australia as well as a range of industries across New Zealand and South East Asia. If you need help and professional advice during any step while managing and storing Dangerous Goods, we are ready to help you too.

For more information regarding the storage of gases in cylinders please contact Walter Ingles at our **STOREMASTA office on 1300 134 223 and walter@storemasta.com.au.** Ask about our risk management and compliance services as well as our range of compliant storage solutions for all types of gas cylinders, chemicals, and other Dangerous Goods,



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