CONFINED SPACES AGSKILLS

NSW GOVERNMENT

Department of Primary Industries

CONFINED SPACES

AGSKILLS

A Practical Guide To Farm Skills

NSW GOVERNMENT
Department of Primary Industries

DISCLAIMER

ACKNOWLEDGEMENTS

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Contents

Foreword

This book is a tool to help identify and manage confined spaces on farms. Too many farmers, their family members and employees have lost their lives because they did not understand the hazards of a confined space and did not take the necessary control measures.

Confined spaces such as tanks, manure pits, silos and storage bins can be dangerous places for workers and other people, who could be exposed to toxic gases and other hazards that may be present in these spaces.

A person conducting a business or undertaking (PCBU) must assess the health and safety risks associated with the identified hazards of the confined space. You must not enter a confined space until identified hazards have been risk assessed by a competent person and all risk control measures to eliminate or reduce risks are in place. The risk assessment must also be reviewed and updated whenever any risks change. A PCBU must not allow or direct a worker to enter a confined space to carry out work unless the PCBU has issued a confined space entry permit for the work.

This book is written for PCBUs, farm owners, employers, managers, supervisors and workers. It can be used as a reference to develop your farm confined space management program and to assist you in meeting the requirements of Work, Health and Safety legislation. It also provides practical guidance for workers who may need to enter and work in a confined space, but it is not to replace the specific training needed before entering and working in such a space.

TRAINING

Confined space training is an essential part of managing confined spaces.

Tocal College, NSW Department of Primary Industries, provides accredited training in confined spaces based on the national unit of competency, RIIWHS202D *Enter and work in confined spaces*.

When is a confined space not a confined space? A manure pit can be deadly.

Incident in animal feed mill kills one worker

A man died while working alone in an animal feed mill. He had entered the bin of moist meal to clear the auger discharge when the meal began to fall on him. He was engulfed by the meal before he could reach the escape ladder. The cause of death was asphyxiation.

Multiple deaths in a manure pit

A 65-year-old dairy farmer, his two sons, a grandson and a nephew died when they entered a manure pit with an oxygen-deficient atmosphere. On the day of the accident, one of the sons entered the pit to repair the agitator shaft. He collapsed, so the nephew yelled to his 8 year old brother to get help. Before help arrived, each of the victims entered the pit to help those who had been overcome and each was overcome in turn.

All five victims died of asphyxiation due to the lack of oxygen. The decomposing manure had not been disturbed for several days and had been releasing flammable and highly toxic gases such as methane and hydrogen sulphide. The methane would have displaced the oxygen and the hydrogen sulphide would have prevented oxygenation of blood from what air was available.

Introduction

Confined spaces pose unique dangers because they are usually not designed to be areas where people work. Confined spaces often have poor ventilation which allow hazardous atmospheres to quickly develop, especially if the space is small.

WHY IS WORKING IN A CONFINED SPACE MORE HAZARDOUS THAN WORKING IN OTHER WORKSPACES?

- the entrance or exit of the confined space may not allow the worker to get out in time should there be a flood or collapse of free-flowing materials
- self-rescue by the worker is more difficult
- rescue of a victim is more difficult as the interior structure of a confined space often does not allow easy movement of people or equipment within it
- natural ventilation alone will often not be enough to maintain breathable quality air
- conditions can change very quickly
- the space outside the confined space can impact on the conditions inside the confined space and vice versa
- work activities may introduce hazards not present initially.

CONFINED SPACE INCIDENTS ON FARMS

The majority of serious incidents and confined space fatalities on farms can be tracked back to two main causes:

- **workers were not trained to recognise a confined space** and have entered the space with no knowledge of the hazards in the space
- **there was no rescue plan** and after the first person got into trouble in the space, other people have rushed in and have become victims themselves.

What is a confined space?

A confined space includes any enclosed or partially enclosed area that:

- is not designed or intended primarily to be occupied by a person
- is (or is designed or intended to be) at normal atmospheric pressure while a person is in the space
- is definitely or is likely to be a risk to health and safety from:
  - an atmosphere that does not have a safe oxygen level
  - contaminants, including airborne gases, vapours and dusts, that may cause injury from fire or explosion
  - harmful concentrations or any airborne contaminants
  - engulfment.

This is the legal definition of a confined space as per the Work Health and Safety (WHS) Regulation.

Even if a space does not meet the regulatory definition it could contain hazards that may be dangerous. A risk assessment should be completed before starting work.

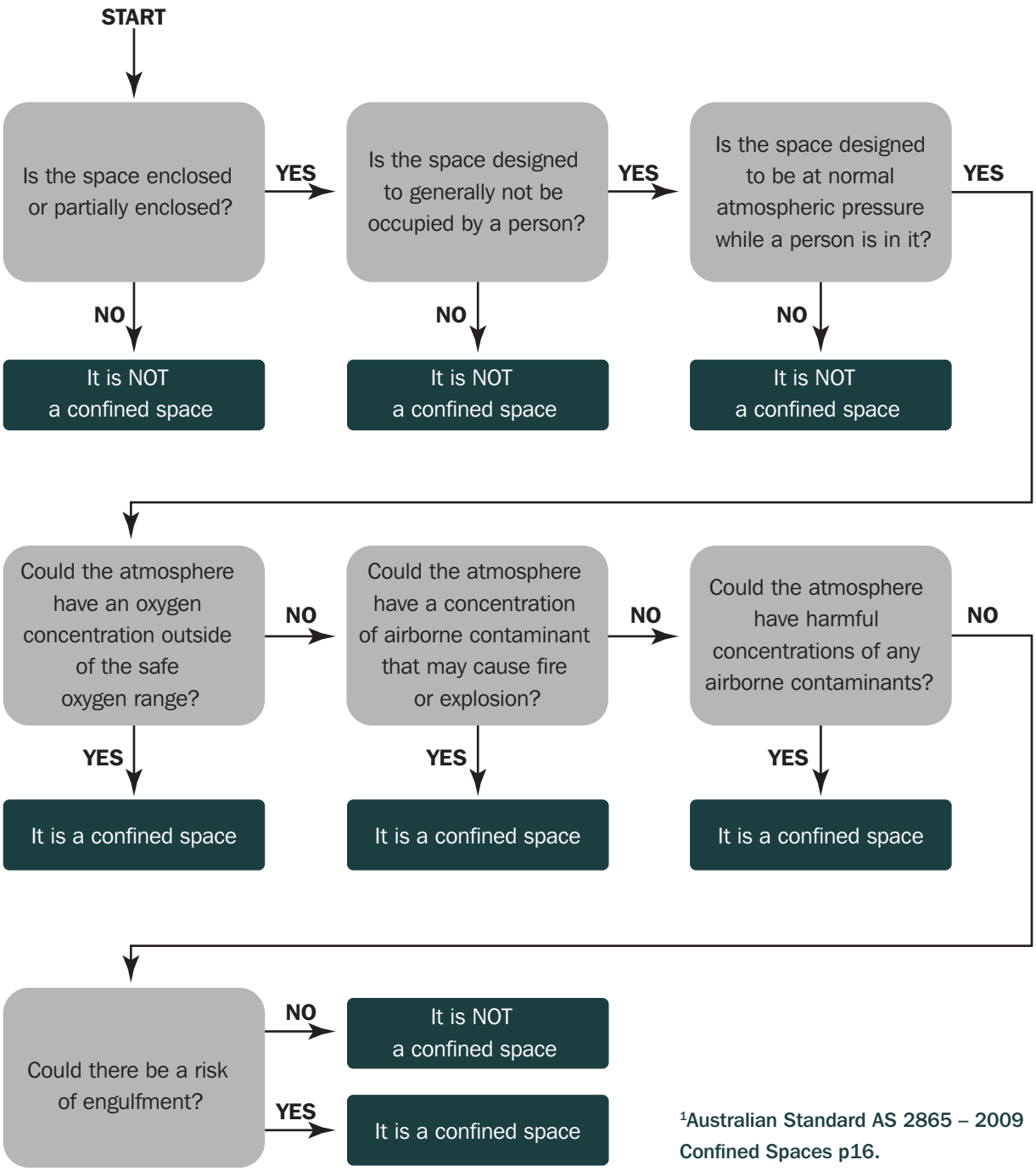
CONFINED SPACES ON YOUR FARM MAY INCLUDE:

- auger and conveyor tunnels
- bulk fuel tanks
- bulk spray tanks
- fertiliser storage tanks
- feed bins
- grain driers
- grape or wine vats
- hoppers and silos
- integrated feed systems
- irrigation pump sites, distribution tanks and pipe work
- milk or cheese vats
- sumps
- sewage tanks or manure pits
- water tanks
- wells.

Does your farm have any spaces like these?

There may be confined spaces on your farm that are not listed here that you need to consider.

You can use a chart like the one shown below to work out if the work area is a confined space[1].



[1]Australian Standard AS 2865 – 2009 Confined Spaces p16.

WORKERS GENERALLY ENTER CONFINED SPACES TO:

- clean and remove waste or sludge
- inspect equipment
- install pumps, motors or other equipment
- complete maintenance work
- read meters, gauges or dials
- rescue workers who are injured or overcome by airborne contaminants.

Entry to a confined space is considered to have occurred when a person's head or upper body enters the space.

WHEN IS IT SAFE TO ENTER A CONFINED SPACE?

Do not enter a confined space unless you can say **YES** to all of the following items:

- a confined space risk assessment has been completed by a competent person
- the atmosphere in the space has been tested to ensure it is safe to enter
- a competent person* has issued a confined space entry permit
- hazardous energy sources (including machinery and pipes) have been isolated where necessary
- the space is properly ventilated
- a standby person is stationed near the entrance of the space for the duration of the work
- there is an emergency procedure and rescue plan for the space
- equipment is available to enter the space and rescue workers in an emergency
- you have been trained to enter and work in a confined space.

*** A *competent person* is a person who has, through a combination of training, education, assessment and experience, acquired knowledge and skills to correctly perform a specified task.**

Confined spaces on farms

INTRODUCTION

Confined spaces on farms come in many shapes and forms. There are also many different hazards that can be present in a confined space. This chapter provides a common list of confined spaces and their hazards to further your knowledge and help you identify these spaces on your farm. You may have additional confined spaces that you need to consider that are not listed here.

AIM

Recognise farm confined spaces and their hazards.

WHAT YOU NEED

This book, training and instruction.

WHAT TO DO

- use the information in this chapter to increase your understanding of confined space hazards
- start to identify the possible confined spaces and their hazards on your farm.

Examples of farm confined spaces

Auger and conveyor tunnel hazards

- lack of oxygen
- toxic and flammable gases e.g. carbon dioxide, hydrogen sulphide, methane, nitrogen dioxide (silo gas), ammonia
- bacteria and mould
- equipment entanglement.

Bulk fuel tank hazards

- lack of oxygen
- toxic and flammable gases, and fuel vapours.

Bulk spray tanks

- lack of oxygen
- cleaning chemicals
- herbicide and pesticide residues.

Hoppers and silos

Milk vats

Sumps

Feed or grain bin hazards

- lack of oxygen in some circumstances
- grain engulfment
- entanglement in equipment
- grain dusts
- pesticide residue.

Hoppers and silo hazards

- lack of oxygen
- toxic gases e.g. carbon dioxide, hydrogen sulphide and nitrogen dioxide, combustible dust
- grain engulfment
- equipment entanglement
- grain dusts
- residue from grain fumigation e.g. phosphine gas.

Integrated feed systems

- lack of oxygen
- toxic and flammable gases e.g. carbon dioxide, hydrogen sulphide, nitrogen dioxide, ammonia and methane
- bacteria
- engulfment.

Irrigation pump sites, distribution tanks and pipe work

- lack of oxygen
- toxic and flammable gases e.g. carbon dioxide, hydrogen sulphide, methane
- engulfment
- bacteria, fungi and moulds
- contact with electricity.


Chaser bin

Mobile equipment hazards (with a holding tank)

- lack of oxygen
- toxic and flammable gases e.g. hydrogen sulphide, methane, ammonia
- herbicides and pesticide residue
- cleaning chemical residue
- bacteria and mould
- stored energy in mechanical and electrical circuits.


Mobile spray tank

Pump stations and sump hazards

- lack of oxygen
- toxic and flammable gases e.g. carbon dioxide, hydrogen sulphide, methane
- engulfment
- bacteria, fungi and moulds
- entanglement in moving parts
- contact with electricity.

Sewage tanks and manure pit hazards

- lack of oxygen
- toxic and flammable atmospheres, e.g. carbon dioxide, ammonia, hydrogen sulphide, methane
- engulfment
- bacteria.


Water tank

Water tanks and well hazards

- lack of oxygen
- toxic atmospheres e.g. carbon dioxide, hydrogen sulphide
- engulfment
- bacteria
- cleaning chemicals and disinfectants
- contact with electricity.

Health and safety rules

INTRODUCTION

Like every other workplace a farm has to follow laws and rules to keep workers safe. There are four main types:

Work Health and Safety Act	This is the law everyone **must** follow
Work Health and Safety Regulations	These explain what the law means by providing additional detail
Codes of Practice	These are guidance instructions on how to follow the law, based on industry standards. There is a Code of Practice written for working safely in a confined space. This can be sourced from Safe Work Australia on their website *www.safeworkaustralia.gov.au*
Australian Standards	These tell you the minimum requirement for a job, product or hazard. AS2865 is the Australian Standard for working in confined spaces

AIM

To comply with Work Health and Safety legal requirements.

WHAT YOU NEED

A good understanding of the legal requirements for confined space.

Silos come in many shapes and forms, each having unique confined space and fall hazards.

WHAT TO DO

Employer responsibilities

If you are a person conducting a business undertaking (PCBU) or employer (or other PCBU) you **must** manage the risks associated with confined spaces and make sure that all hazards have been eliminated or minimised, **as much as is reasonably possible.**

You **must** also ensure that before worker(s) enter a confined space:

- a competent person has conducted a written risk assessment
- a confined space entry permit has been issued
- suitable information and training has been given to workers
- appropriate signage is in place
- communication and safety monitoring systems are in place
- required risk controls on energy sources, connected plant, atmosphere, flammable gases, fire and explosions are complied with.

You **must** also have emergency procedures and rescue equipment in place and comply with record keeping requirements.

A summary of legal requirements for a PCBU (employer) is provided on pages 75-76.

Worker responsibilities

To keep yourself and other workers safe you **must**:

- follow safe work procedures
- contribute to hazard identification, risk assessment and control
- wear personal protective equipment as instructed
- cooperate with others in the atmospheric monitoring process, and
- report any problems.

In this book the word must is used to indicate a mandatory requirement under the Work Health Safety Act and/or Regulation

Creating a confined space management program

INTRODUCTION

This chapter is aimed at farm owners and farm managers. To safely control the risks associated with working in confined spaces across the farm, you should develop and implement a confined space management program.

There are **seven steps** in creating the program:

1. identify all confined spaces
2. create an inventory of the spaces
3. look at ways to make confined space entry safer
4. sign and secure confined spaces
5. develop emergency procedures
6. develop written entry, work and exit procedures
7. provide information and training to workers.

AIM

Create a confined space management program.

WHAT YOU NEED

- competence in confined space risk assessment
- access to the farm to identify spaces (without entry)
- access to workers for consultation
- confined space identification matrix
- hazard identification checklist
- camera
- list of confined spaces
- confined space signage, at least one sign per space
- tools and materials to erect signage
- bolts and padlocks
- equipment to install bolts and locks
- fencing equipment and materials
- key storage cabinet or box
- key tags
- Information and training.

WHAT TO DO

Step 1: identify all confined spaces

A confined space is determined by the structure and a specific set of conditions. The same structure may or may not be a confined space depending on the conditions (e.g. new structure, empty or full container, work task) when the space is entered. For example, entering a newly installed empty silo or water tank would not necessarily be a confined space. However, if the silo or tank contains materials that could pose a risk then it would be treated as a confined space.

To identify your confined spaces you should:

- inspect the workplace to identify possible confined spaces. Examples include:
  - auger and conveyor tunnels
  - bulk fuel tanks
  - bulk spray tanks
  - fertiliser storage tanks
  - feed bins
  - grain driers
  - hoppers and silos
  - integrated feed systems
  - irrigation pump sites, distribution tanks and pipework
  - milk or cheese vats
  - sumps
  - sewage tanks or manure pits
  - water tanks
  - wine or grape vats
  - wells
- consult with workers to see if they can identify additional confined spaces
- identify each space by using the sample confined space identification matrix on the next page. By following the steps A to D and answering yes or no to the questions the classification for a confined space can be confirmed
- document your results.

SAMPLE CONFINED SPACE IDENTIFICATION MATRIX							
	CONFINED SPACE CRITERIA[2]						CONFINED SPACE?
Description of the space and activity	A	B	C	D			If the answer to A, B, C and at least one of D is yes, then the space is a confined space
	Is the space enclosed or partially enclosed	Is the space not designed or intended to be occupied by a person	Is the space designed or intended to be, at normal atmospheric pressure while any person is in the space	Does the space present a risk from:			
				Harmful airborne or flammable contaminants	An unsafe oxygen level (safe level is 19.5% to 23.5%)	Engulfment	
Sewer with access via a vertical ladder	✓	✓	✓	✓	✓	✓	Yes
Dislodging grain from a silo with sole access through a manhole at the top	✓	✓	✓	✓	×	✓	Yes
Internal inspection of an empty cement silo through a door at ground level	✓	×	✓	×	×	×	No
Internal inspection of a new, clean water tank before installation	✓	✓	✓	×	×	×	No

[2] Confined Spaces Code of Practice, 2014, Appendix A – Confined Space Criteria, Safe Work Australia.

Involve workers in identifying confined spaces and their hazards.

Step 2: create an inventory of the confined spaces

- As part of the farm confined space management program you should develop and maintain a written inventory of all confined spaces. To create an inventory:
  - locate the list of confined spaces from the previous step
  - for each confined space complete an inventory worksheet (sample provided on next page)
  - consult workers to identify the tasks performed in confined spaces and the associated hazards
  - consider taking a photograph of each space to keep as a record
  - on completion of inventory worksheets get workers to review results and provide feedback
  - save results of each worksheet as the completed worksheets form part of the farm confined space entry program e.g. they could form an annex in procedures
  - consider communicating the completed confined space inventory in safety inductions.

You could use the following worksheet to help complete the inventory of confined spaces on your farm.

SAMPLE CONFINED SPACE INVENTORY WORKSHEET	
Description and location of the confined space	
Confined space number (optional)	
Photo	
Date identified as a confined space	
Confined space identified by	
Access/egress	(Describe the locations, size and shape of openings. Vertical or horizontal)
Contents of the space	(E.g. manure, grain, water)
Equipment in the space	(E.g., pumps, augurs or valves)
Describe hazards inherent to the space	
Describe hazards adjacent to the space	
Security	(E.g., signage, barriers, fencing, locks)
Entry required	Yes/No and reason:
Additional comments	

Step 3: look at ways to make confined space entry safer

The best way to avoid confined space hazards is to find another way to do the work outside of the space. If you cannot avoid working inside a confined space, look for ways to minimise the risks and make it safer.

For each identified confined space consider

- modifying the space to make it safer for workers, e.g. can the access point(s) be enlarged or moved to make it easier for workers to use, or if the worst happens for victims to be rescued (unconscious persons are difficult to manage through restricted access ways)
- modifying the task so that the work can be performed from outside of the space, e.g. using a portable vacuum system to remove remaining material from a bin without entering the space
- permanently moving equipment to a new location outside the confined space so there is no need to enter the space
- modifying equipment so it can be removed from the confined space for maintenance and repair, e.g. installing a removable agitator system in a manure pond so workers won't have to enter the pond when repairs are needed
- using remote cameras or installing viewing windows to conduct inspections from outside the space, removing the need to enter
- installing access hatches in the walls of the confined space letting you access equipment in the confined space without physically entering it
- consulting with workers as they will have ideas on how to avoid confined space entry and how to make it safer
- using a confined space expert to review your spaces and provide recommendation on how to reduce the risk.

Contracting out confined space work

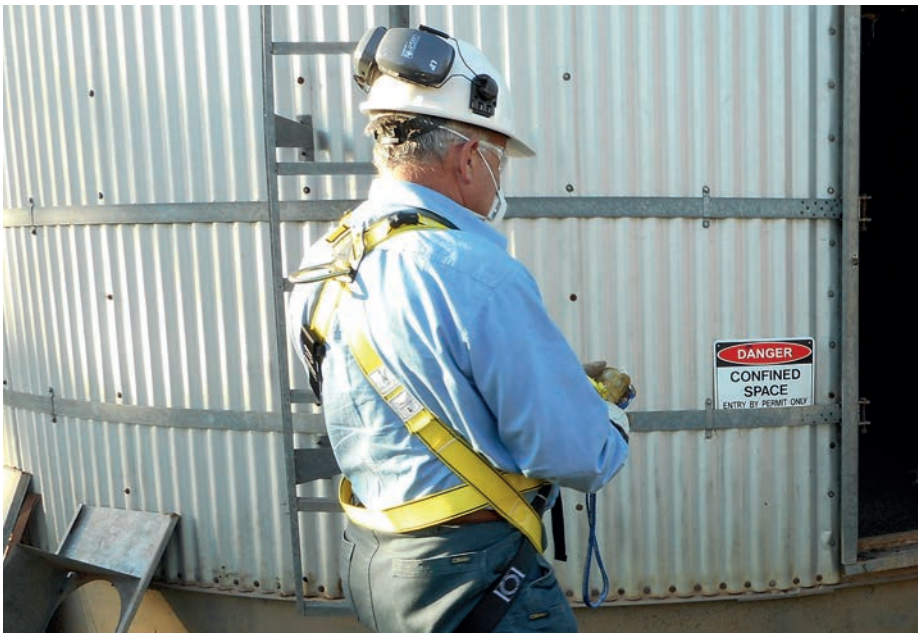
- hiring a qualified contractor is a good way to ensure work safety and delegate the requirement for specialised training and equipment
- if using contractors you will still need to check that they are competent to enter and work in confined spaces
- also check that any equipment they are using has been calibrated and maintained e.g. gas detector, rescue equipment
- make sure the contractor has their own confined space entry program that has documented procedures for safe entry before they begin work on your farm.

Deciding which spaces to enter

To finish this step go back to the confined space inventory and decide which spaces are to be:

- modified (structure or task)
- entered by farm workers
- entered by contractors.

Update the inventory and use this information in developing procedures (Step 7).



Make sure signage is placed next to all entry points.

Step 4: signs and security

Many confined space incidents and fatalities involve workers or others (including children) entering a confined space without recognising that they have entered the space. To prevent this you should place permanent warning signs on all confined spaces and secure all confined access points to prevent accidental and or unauthorised entry.

Place permanent warning signs

- place signs on each confined space
- place the sign on or next to the confined space entry point
- inspect signs regularly to ensure they have not been damaged and are readable, and visibility is not obstructed by vegetation, materials or equipment or has been faded by ultraviolet radiation.

When not in use all confined space entry points should be secured.

Securing confined spaces

- install bolts and locks on all covers, doors and lids that provide access
- a lock may not be required if a cover or lid is bolted in place and requires tools for removal, or if the cover or lid is heavy enough to require tools or equipment for removal
- if you are unable to lock covers and doors you may need to erect a perimeter fence with a locked gate to secure the area
- pits should have barriers installed around the sides, any gates in the barriers should be locked
- create a controlled storage area for keys
- name and or number the keys for each confined space on each key tag
- regularly inspect spaces to ensure access remains secure.

13 year old boy dies in well

A 13 year old boy died while playing with five other children in an underground well. They had used newspapers to start a fire, but became frightened of the smoke. Four of the boys managed to climb up the rope and out of the well but the fifth boy did not escape. A man who attempted to rescue the boy collapsed and was hospitalised.

The boy probably died from the toxic carbon monoxide produced by the fire and from a lack of oxygen.

Step 5: develop emergency procedures

Emergency procedures (first aid and rescue) must be developed, implemented and practised with workers.

Emergency procedures must also be initiated from outside the confined space as soon as possible in an emergency.

Workers performing rescue must have adequate training and must be provided with and wear appropriate respiratory equipment and a full body harness if they are to enter a confined space in an emergency.

You must also make sure that the entry/exit openings are large enough to allow for emergency access and that they are not obstructed, and any equipment provided for first aid or rescue is maintained in good working order.

When developing emergency procedures consider the following:

Location of the confined space
- how accessible is it in an emergency?
- how far away is it from appropriate medical facilities?

Communications
- how can workers inside the space communicate with people outside in an emergency?
- how will the alarm be raised and by whom?

Training
- how will workers be trained?
- how will you practise the emergency procedure with workers and how often?

Rescue equipment
- what kinds of emergencies are expected? E.g. a worker with a broken leg from a fall or a worker unconscious at the bottom of a space, or a fire or explosion
- rescue equipment needs to be available that matches the potential emergencies
- if a worker inside a confined space is overcome by lack of oxygen or airborne contaminants always assume that entry for rescue is unsafe unless air-supplied respiratory protective equipment is used.

Capabilities of rescuers
- are rescuers properly trained? E.g. air-supplied breathing apparatus, lifelines and firefighting equipment
- how will rescuers be kept safe during the emergency?

First aid
- is appropriate first aid available for immediate use?
- are trained first aid personnel available?

Fire
- is fire anticipated?
- what fire control measures are needed? E.g. fire blankets, fire extinguishers.

Local emergency services
- who will notify them?
- what would be their average response time?
- what rescue equipment do they have available?
- are they trained in confined space rescue?

Many small rural fire services do not have technical rescue capabilities and suitable rescuers from larger centres may take considerable time to respond.

Training is an essential part of a confined space management program.

Step 6: provide information and training to workers

Training should be provided to workers who

- enter or work in confined spaces
- undertake hazard identification or risk assessment in relation to a confined space
- implement risk control measures
- issue entry permits
- act as a standby person or communicate with workers in a confined space
- monitor conditions while work is being carried out
- purchase equipment for confined space work
- design or lay out a work area that includes a confined space.

The training provided to relevant workers must cover

- the nature of all hazards associated with a confined space
- the need for, and appropriate use of risk control measures
- the selection, use, fit, testing and storage of any personal protective equipment
- the contents of a confined space entry permit
- emergency procedures.

Refresher training

- this should be provided as needed for your workplace
- the frequency of this training will depend on how often workers are required to work in a confined space.

Step 7: develop written entry, work and exit procedures

Using the information collected in the previous steps, you are now ready to develop written procedures for workers to follow.

The complexity of these procedures will depend on the type of confined space being entered, the types of hazards and the type of work that is being done in the space.

What to include in procedures

- who is the accountable person for the confined space management program
- who is a competent person to complete confined space risk assessments and authorise confined space entry permits
- assignment of a standby person
- gas testing and monitoring requirements
- lockout and isolation procedures
- ventilation equipment and requirements
- description and use of personal protective equipment (PPE)
- emergency procedures and rescue equipment that need to be available
- name and contact details of equipment suppliers or hire companies
- when to use contractors for confined space work
- what type of training workers need
- signage and security
- confined space inventory
- hazard identification checklist (optional)
- risk assessment template
- confined space entry permit template
- record keeping requirements.

Consider getting help

- a competent person needs to write the procedures
- consider using a confined space expert to complete this task.

Train all workers on the procedures

To complete your confined space management program you need to train your workers on the procedures. This includes new and existing workers who work in a confined space.

Identifying hazards

Identifying hazards involves finding out what things and situations could cause harm to a person.

All reasonably foreseeable (or expected) hazards must be identified.

For confined spaces this means identifying the hazards of the confined space, the hazards of the work to be done in the space and any hazards that are produced as a by-product of the work done in the space.

Gas testing is a routine part of identifying atmospheric hazards and is covered in a separate chapter.

This chapter covers:
- breathing hazards
- gases that cause fire and explosion
- engulfment hazards
- other hazards.

AIM

Identify all foreseeable hazards.

WHAT YOU NEED

Person(s) competent in confined space risk assessment.

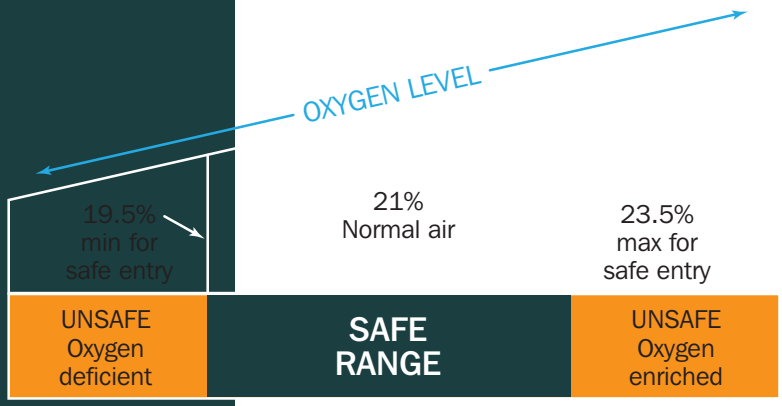
WHAT TO DO

Breathing hazards

Breathing can be affected by:
- the amount of oxygen in the air
- toxic gases in the air
- dusts/particulates
- disease causing agents such as mould spores, bacteria, or viruses.

A safe level of oxygen

- in order to function normally, the oxygen we breathe **must** fall within a 'safe' range of **no less than 19.5% and no more than 23.5%**
- too much oxygen in the air will make combustible materials easier to ignite and burn, increasing the risk of fire and explosion in a confined space.



Know how the human body responds to oxygen deficiency

- the human body needs an oxygen concentration of 21% to function normally
- oxygen concentrations down to 16% may be tolerated for short periods
- oxygen concentrations less than 16% quickly lead to unconsciousness and death.

Effect of oxygen deficiency on the human body

21%	Normal concentration
16%	Rapid breathing and pulse rate increased
14%	Loss of muscular coordination, laboured breathing, fatigue, impaired judgement, developing cyanosis
10%	Nausea, headache and vomiting, unable to move freely, liable to lose consciousness, very rapid breathing
6%	Convulsive movements, gasping breathing, heart and breathing may cease. Minimum amount that will support life
2 – 3%	Death within 1 minute

Understand the causes of oxygen deficiency in confined spaces

- oxygen is used up during combustion e.g. during cutting or welding, by internal combustion engines and burning materials
- oxygen is used up when metals rust
- oxygen can be replaced by other gases e.g. the contents of a sewage pit (or a fermenting wine vat) resulting in the absorption of oxygen and the production of carbon dioxide
- microorganisms can use up oxygen e.g. in sewer lines, sumps and manure pits
- in some situations, oxygen may bind with the surface of a material within a confined space e.g. grains, soil or chemicals in sealed silos
- purging of a confined space with inert gas (e.g. nitrogen) to remove flammable or toxic fumes.

How can you be sure there is enough oxygen in the air?

- you cannot see or smell an oxygen deficient atmosphere, so there is usually no warning of the hazard
- the only way to know how much oxygen is present in a confined space is to conduct an atmospheric test using a properly maintained and calibrated gas detector
- the gas detector should be set to alarm if the oxygen percentage is less than **19.5%** and more than **23.5%**
- workers **must** not enter a confined space with an oxygen level less than 19.5% unless they are wearing air supplied breathing apparatus.

Understand toxic atmospheres

- confined spaces may contain toxic gases and these gases can accumulate in the space at different levels
- do not assume that because the air seems good in one area of a confined space that it is safe throughout the space
- in some cases, the toxic gases are generated within the confined space (such as fermentation gases). In other cases, the toxic gases flow in to the confined space and then remain there. This can happen with carbon monoxide, if a combustion engine is running near a confined space
- the toxic gases most commonly found in farm confined spaces are:
  - ammonia
  - carbon dioxide
  - carbon monoxide
  - hydrogen sulphide
  - methane
  - nitrogen dioxide
- all these gases can be detected using a suitable gas detector equipped with appropriate sensors.

You can't smell an oxygen-deficient atmosphere.

Identify and understand exposure limits for atmospheric contaminants

Safe Work Australia (SWA) describes levels of exposure to atmospheric contaminants above which negative health effects are expected.

There are **three categories** of exposure standards:

1. TWA – Time Weighted Average
   - the average airborne concentration of a substance when calculated over a normal eight hour day for a five day working week.

2. STEL – Short Term Exposure Limit
   - the airborne concentration of a substance averaged over a 15 minute period
   - it should not be exceeded at any time or form more than four 15 minute periods during a normal eight hour day
   - at least 60 minutes should be allowed between each successive exposure.

3. PEAK – Peak Limitations
   - the concentration that should not be exceeded even for an instant during any part of the work.

More information on exposure standards

For a copy of the exposure standards, refer to Safe Work Australia on their website *www.safeworkaustralia.gov.au*

Exposure standards for the six common farm toxic gases (as of 2015*)

EXPOSURE STANDARD Values in parts per million (ppm)			
Gas or Vapour	TWA	STEL	PEAK
Ammonia	25	35	-
Carbon Dioxide	5,000	30,000	-
Carbon Monoxide	30.0	-	-
Hydrogen Sulphide	10.0	15.0	-
Methane	-	-	-
Nitrogen Dioxide	3.0	5.0	-

**SWA has recommended guidelines to control short-term excursions above the TWA for carbon monoxide. A guidance table for the control of short-term excursions may be found in the National Commission Documentation for carbon monoxide.*

- methane does not have an exposure standard. This is because it presents a risk to health by displacement or dilution of oxygen, rather than from exposure to the substance
- workers **must not** be exposed to atmospheric concentrations **greater** than the exposure standard
- because of the increased risk of injury and illness in a confined space, exposure to all atmospheric contaminants **should be reduced** to as low as reasonably practical, **even if they are already below** the exposure standard.

Health impacts and features of the six common toxic gases found in farm confined spaces

GAS	SOURCE	DESCRIPTION			
		Odour and colour	**Impact to health**	**Flammability***	**Behaviour in the confined space**
Ammonia (NH_3)	Produced when high nitrate organic material such as manure and urine is decomposed by bacteria	Stinging or pungent smell	Causes irritation to the eyes, nose, and lungs; can cause lung damage and death at high concentrations	Yes (LEL 15%)	Lighter than air – may rest on top of space
Carbon Dioxide (CO_2)	Produced by all living organisms that breathe oxygen. Also a by-product of fermentation	Odourless in low concentrations, slightly pungent in high concentrations	Displaces oxygen – fatigue, headache, drowsiness, death via asphyxia	No	Heavier than air – sinks to bottom of space
Carbon Monoxide (CO)	Comes from all sources of combustion e.g. petrol or diesel engines and welding activities	Odourless and colourless	Can cause unconsciousness, brain damage and death	Yes (LEL 12.5%)	Heavier than air – sinks to bottom of space
Hydrogen Sulphide (H_2S)	Released when organic material (e.g. manure or sewage) breaks down without oxygen	Rotten egg odour at low levels, odourless at high levels	Can cause respiratory failure and death	Yes (LEL 4%)	Heavier than air – sinks to bottom
Methane (CH_4)	The main gas produced during the bacterial digestion of manure	Odourless and colourless	Displaces oxygen – death via asphyxia	Yes (LEL 5%)	Lighter than air – may rest on top of space
Nitrogen Dioxide (NO_2)	Produced as plant material is transformed into silage (also known as silo gas). Can also be produced by oxy cutting and gouging	Can sometimes form a reddish brown haze in the air. Bleach-like smell	Respiratory irritant; can be fatal at high concentrations	No	Heavier than air – sinks to bottom of space

*Once the Lower Explosive Limit (LEL) is achieved these gases have entered their flammable range and have the potential to explode on ignition.

Brothers die in water tank

Two brothers aged 24 and 26 died of carbon monoxide poisoning in a water tank on their father's farm. The brothers had been using two petrol-driven pumps to empty the 50,000 litre underground tank because it had been polluted by a dead possum.

During the job, the men discovered that neither of the pumps was fitted with a hose long enough to reach the bottom of the tank. In an attempt to get all the water out, one pump was lowered about a metre into the tank and secured by ropes. When the water was only about 240 millimetres deep, one brother got into the tank to put bricks on the hose to keep it on the bottom. He collapsed and the other brother and a friend quickly climbed in to try and rescue him. The second brother collapsed, while the friend, who was nearly overcome by fumes, managed to get out of the tank and get help. Both brothers were dead on arrival at the local hospital.

Phosphine

- phosphine is used to control pests in stored grain
- phosphine is a schedule seven **DANGEROUS POISON**
- before entering a confined space that is used for grain storage, find out whether the grain has been recently fumigated with phosphine. If it has, then the space will need to be thoroughly ventilated for up to five days before entry
- specific exposure standards have been set for workers who come in contact with the grain after fumigation
- **never** rely on the odour of phosphine to determine if the atmosphere is safe. Phosphine gas detectors are available.

Breathing hazards include dusts, mould spores, bacteria, and viruses

- the air in any confined space can build up higher levels of contaminants than the surrounding outside air
- many confined spaces have much higher humidity than outdoor air, and the moist environment can promote the rapid growth of these organisms
- dust may be mixed with mould spores, some of which can cause fungal diseases in the respiratory system, or allergic reactions
- high dust levels may also limit workers' ability to see and work safely in the space.

Gases that could cause fires or explosions

Understand common ignition sources

- ignition sources provide enough heat energy to ignite a flammable or explosive atmosphere
- an ignition source can be a spark, a flame or just a hot surface.

Main causes of an oxygen-enriched atmosphere

- poorly designed or maintained oxygen storage equipment, e.g. leakage can occur from oxygen lines, pipes, fittings and thus, unintentionally enrich the atmosphere
- some industrial processes can also bring about excess oxygen, e.g. improper use of oxy-propane welding equipment
- high oxygen levels support rapid combustion
- the risk of fire and explosion is significantly increased in oxygen-enriched atmospheres (greater than 23.5%).

Understand why fires and explosions occur in a confined space

- an atmosphere becomes flammable and explosive when a mixture of oxygen and flammable material is present in the proper proportions. If an ignition source is also present, combustion (burning) of the atmosphere occurs

- all flammable vapours, gases and dusts have a **minimum** concentration below which the spread of flame **does not occur** on contact with an ignition source. This is known as the **lower flammable explosive limit** (**LEL**)
- on the other end of the scale, there is also a **maximum** concentration of vapour or gas. In air above this level, the spread of flame **does not occur**. This is known as the **upper explosive limit** (**UEL**)
- each flammable gas has its own LEL and UEL
- gas detectors should be calibrated with the gas of interest.

Flammability of methane

- methane is lighter than air and rises to the top in confined spaces. It mixes readily with air and other gases to form a potentially explosive mixture
- methane is explosive when mixed with air in a concentration between 5% LEL and 15% UEL.

Flammability of hydrogen sulphide

- as well as being a toxic gas, hydrogen sulphide is also flammable
- if high concentrations mix with air in a confined space, there could be an explosion
- hydrogen sulphide is explosive when mixed with air in a concentration of 4% LEL to 46% UEL
- due to its toxicity hydrogen sulphide becomes a **poisoning danger long before** it poses an explosion hazard.

Know the main causes of flammable atmospheres

Inadequate venting of contents. One of the most frequent causes of explosions in confined spaces is inadequate venting. *E.g. if a tank that has a capacity of 100,000 litres has only been 99% vented, this means there is still 1000 litres of the product, (i.e. petroleum vapours, which could settle and form an explosive mixture).*

Cleaning agents. Cleaning processes may require spray painting or cleaning by use of solvents, both of which can be flammable.

Chemical reactions. Strong bases such as Caustic Soda react with some metals such as aluminium, chromium and zinc to produce hydrogen gas.

Decomposition. Decomposing organic material can produce methane and hydrogen sulphide.

Leaking cylinders or pipes/hoses. Leakage of cylinders can occur as a result of the type of work being performed in the space e.g. cylinders containing LPG or propane gas may be used for hot work and if they have faulty seals, their gases may accidentally be released within the space.

Contaminants. Flammable products such as petroleum and LPG are heavier than air. This means they can flow in confined spaces lower than the source of the leak.

Always check for a flammable atmosphere in a confined space

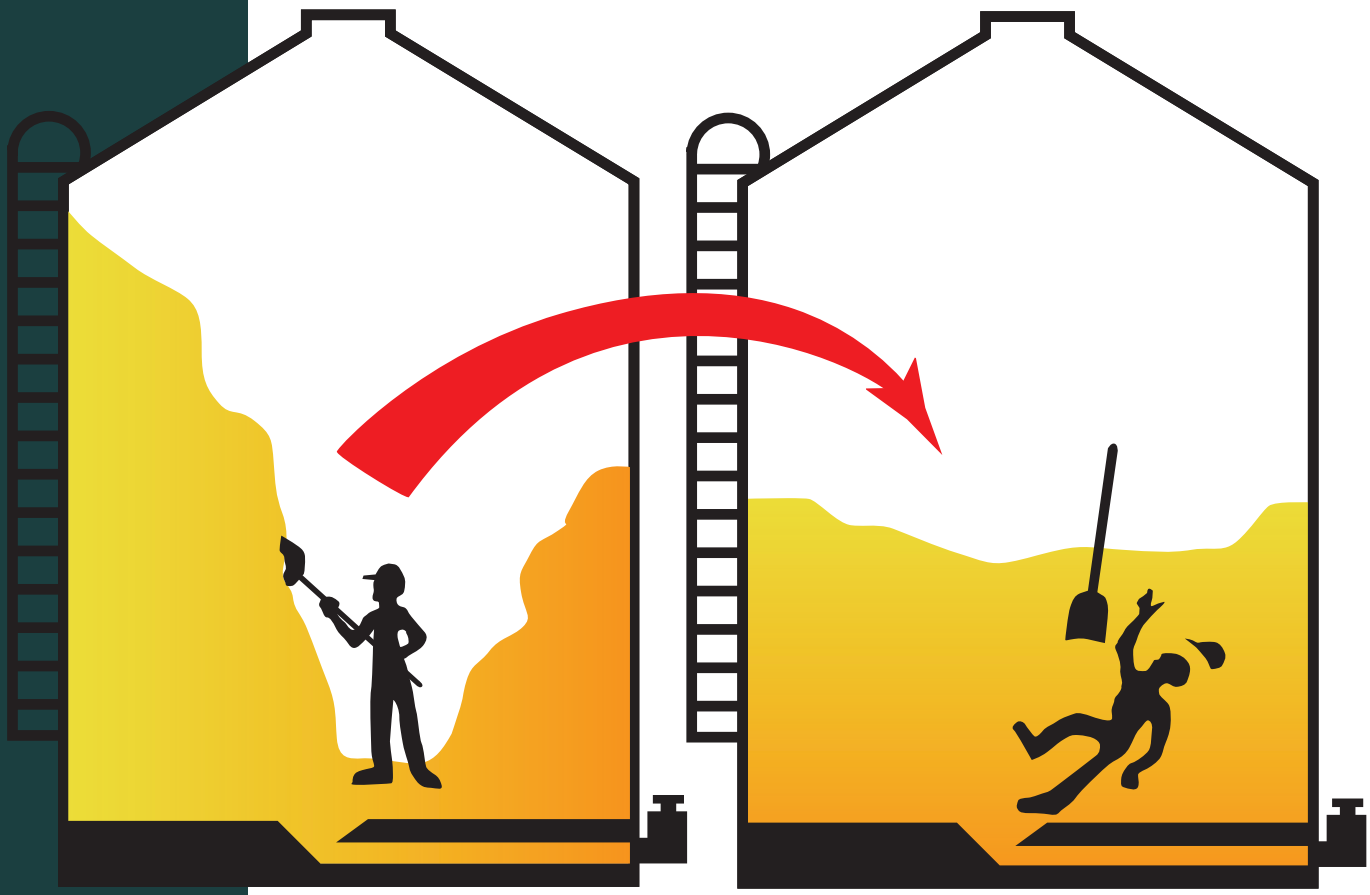
- never use a simple oxygen gas detector to check for flammable atmospheres
- only a gas detector with an explosive gas sensor will warn of fire and explosion hazards.

Explosive (combustible dusts)

- is any fine material that has the ability to catch fire and explode when mixed with air
- can sometimes be found in a variety of confined spaces including storage bins, process hoppers and grain silos
- normally the dust will form during the processing of this material or the loading and unloading of it.

A gas is only explosive between its LEL and UEL. Safe limits of flammable gases must not exceed 5% of its LEL.

In the U.S. over the last 35 years, there have been over 500 explosions in grain handling facilities, which have killed more than 180 people and injured more than 675.



Example of engulfment occurring by avalanche of materials from above.

Engulfment hazards

Materials stored in or around confined spaces (e.g. sawdust, liquids, grains, animal feeds, sewage or soil) can surround, trap and engulf a person within seconds. Often the victim is unaware of this hazard, when a seemingly solid surface gives way under their weight. As the person tries to escape, their movement only draws them deeper into the material. Once engulfed, the pressure exerted on the person's body makes breathing difficult or impossible. Once this supply of oxygen is cut off, death can occur within four minutes.

Engulfment can also occur when an 'avalanche' of material is disturbed and rapidly engulfs the victim from above, particularly if working near the edge of the material such as through an access hatch or door.

Understand how engulfment can happen

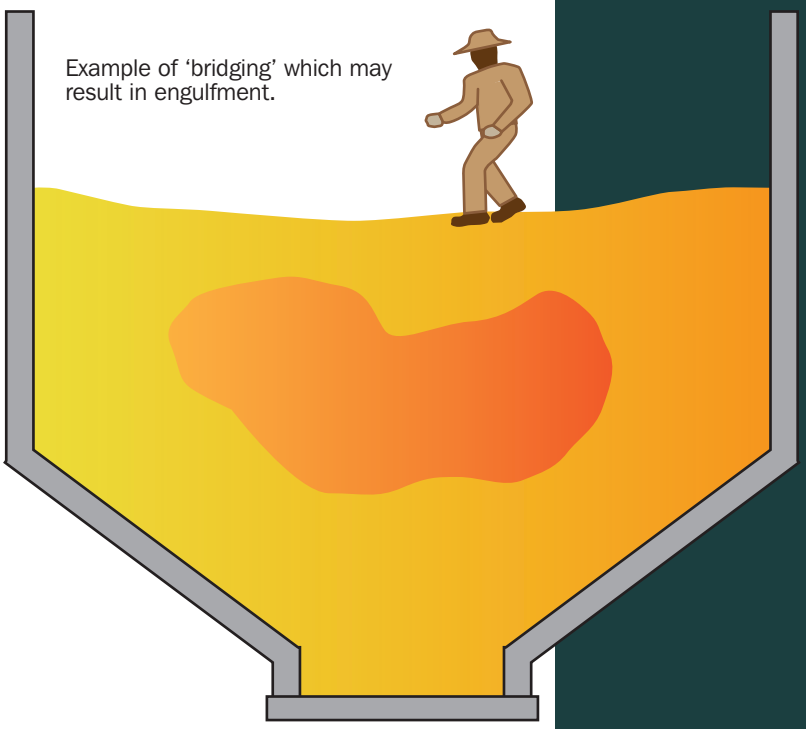
- a specific type of engulfment hazard also occurs when material is being drawn out from the bottom of a storage bin
- as the material flows from the bottom outlet, a funnel-like depression forms throughout the material
- if a person becomes trapped in this depression, engulfment and complete burial may occur within seconds.

Bridging

Another type of engulfment hazard is known as bridging.

This hazard occurs when storing moist or powdery materials such as grain. Over time, a hard crust can build up on top of confined spaces such as silos, hoppers or storage bins.

When material is emptied from the bottom of the space, the bridge can easily collapse under a person's weight without warning.



Example of 'bridging' which may result in engulfment.

Drowning hazards

- confined spaces should be fully drained or dry when entered and sources of liquid that could enter the space isolated to prevent release into the space
- spaces that are not fully drained or dry pose a risk of drowning.

You can drown in a small pool of liquid, e.g. you collapse due to insufficient oxygen and fall face down in centimetres of liquid and drown.

Other hazards

Other hazards can be introduced into a confined space by the work being done and through the by-products that result from the work e.g. fumes from hot work.

When identifying other hazards consider the following

Restricted entry or exit

- small entrances and exits make it difficult to rescue injured workers or to get equipment in or out of the confined space.

Uncontrolled entry of substances

- steam, water or other liquids, gases or solids may result in drowning, or being overcome by fumes or other harm depending on the nature of the substance
- vehicles operating close to the opening of the confined space can cause a build-up of exhaust gases, including carbon monoxide, in the space.

Electrical hazards

- may cause electrocution, shocks or burns, and can arise from cables, transformers, capacitors, relays, exposed terminals and wet surfaces where electrical circuitry and electrically powered plant are used.

Plant and machinery hazards

- augers, conveyers and pumps, are commonly found in confined spaces presenting the risk to workers of entanglement, cutting, crushing or other acute injuries if not adequately guarded or isolated before entry.

Biological hazards

- contact with micro-organisms, such as viruses, bacteria or fungi, may result in infectious diseases, dermatitis or lung conditions such as hypersensitivity pneumonitis
- sewers, grain silos and manure pits may contain biological hazards.

Falls

- accessing vertical pits or openings high up in silos may require the use of ladders, hoists or other devices to prevent workers falling
- where the confined space has a vertical opening, there is a risk that workers and others could fall in.

Noise

- noise levels can be amplified within a confined space, reducing the length of time workers are able to work without hearing protection
- noise can restrict communication between people working in a confined space and the standby person.

Thermal hazards

- hot environments can affect workers through the onset of heat-related illness such as cramps, exhaustion and heat stroke
- low temperatures in confined spaces can lead to reduced mental alertness, hypothermia and frostbite.

Manual tasks

- hazards from manual tasks may be made worse by the physical limits associated with working in a confined space
- additional hazards may arise from the use of personal protective equipment that restricts movement, grip and mobility.

Hazardous chemicals

- the nature of a confined space could increase the likelihood of skin contact with surface contaminants
- always check the Safety Data Sheet of the products you are taking into the space for safety and risk information and be especially aware of the LEL
- if you are using chemicals you should be trained in Chemical Application (Level 3) as a minimum e.g. SMARTtrain®.

Hazards outside the confined space

- work done outside the space, but near openings to it, can contaminate the atmosphere inside the space, e.g. exhaust gases from an internal combustion engine
- there may be potential for fire or explosion where hot work is done in areas next to confined spaces that contain flammable atmospheres.

Additional demands on the body

Consideration should be given to a worker's:

- physical ability
- ability to work in a restrictive space (for example claustrophobia)
- ability to wear the personal protective equipment required to do the work (e.g. respirators).

Conduct confined space risk assessment

INTRODUCTION

A risk assessment involves considering what could happen to a person when they are exposed to a hazard and deciding what to do about it (eliminate or minimise the risk).

Hazards and risks are not the same thing:

- a **hazard** is a situation or thing that has the potential to harm a person
- a **risk** is the possibility that harm (death, injury or illness) might occur when exposed to a hazard
- a **risk control** is something that is put in place to eliminate or minimise the risk.

For example, a hazard is an oxygen deficient atmosphere (source of harm), the risk is asphyxiation (what will happen when the person is exposed to the hazard). A risk control could be the use of mechanical ventilation to maintain a breathable atmosphere.

A competent person(s) must undertake a **written risk assessment** before work is carried out in a confined space.

This usually involves the following steps:

1. identifying hazards
2. assessing the risks associated with the hazards
3. deciding on risk control measures
4. implementing and monitoring the control measures.

AIM

Complete confined space risk assessment.

WHAT YOU NEED

- competent person(s) to complete the risk assessment
- hazard identification checklist (optional)
- risk assessment template
- gas detector.

WHAT TO DO

Step 1: Identify all hazards

- identify all hazards inherent with the confined space
- consider the hazards of the work that is to be done in the space
- consider work that is being done in adjacent work places that may introduce hazards into the space
- conduct an atmospheric test using a gas detector to identify atmospheric hazards (covered in separate chapter)
- remember to consult with workers and find out what they think the hazards are
- be thorough in this step as any hazard missed is not considered in risk assessment and risk control.

Consider using a hazard checklist

- a hazard checklist is a good tool to help with hazard identification
- a sample confined space checklist is provided on page 34. To use a checklist like this you would check the box next to the hazards identified
- the completed hazard identification checklist can then be used as a basis for risk assessment.

Are the conditions or substances created by your actions dangerous?

Step 2: assessing risk

You should now have a list of hazards from Step 1. Using a risk assessment template (a sample risk assessment template is provided on page 35) write down every hazard and associated risk on the template. Use a separate line for each risk. You then need to estimate the consequence of the risk and the likelihood of the consequence occurring. Record this on the risk assessment template.

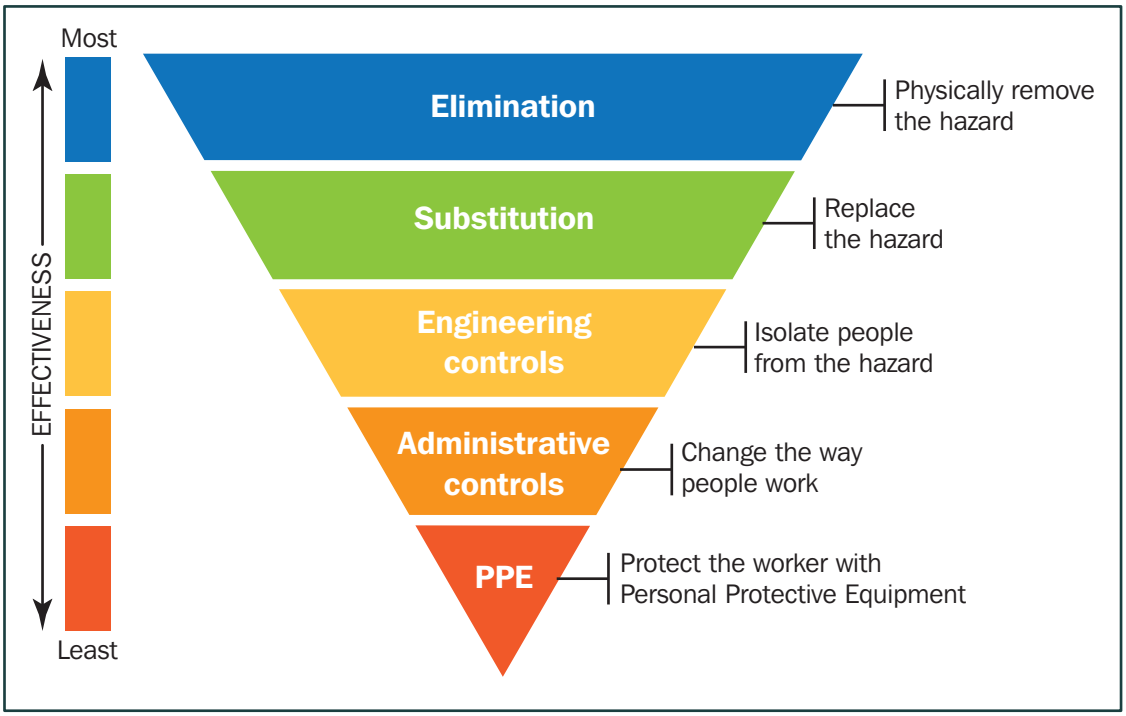
When assessing risk always consider:

- the atmosphere in the confined space
- the risk of engulfment
- all proposed work activities
- the number of workers
- soundness of the structure
- the need for lighting
- what substances will be brought into the space
- what substances may be generated in the space by your actions e.g. carbon monoxide from welding, nitrogen dioxide from gouging and cutting
- if hot work is necessary
- the number of persons needed outside the space to maintain equipment, monitor safety and initiate a rescue
- arrangements for emergency response e.g. first aid
- what personal protective equipment is needed
- what rescue equipment is needed
- what controls may need to be implemented in adjacent work areas.

Step 3 and 4: for each risk identify and implement risk controls

For each risk recorded on the risk assessment you need to put a risk control in place to either eliminate or minimise the risk.

The ways of controlling risks are ranked from the highest level of protection and reliability to the lowest. This ranking is known as the **hierarchy of control and must be followed.**



Hierarchy of control.

Hierarchy of control - elimination examples

- initial design of the confined space that eliminates the need for entry
- performing the task or process from outside the confined space (e.g. if a meter or gauge needs to be read, can it be relocated outside the confined space)
- retrieving an object with long handled tools
- cleaning walls through side and top access points
- using internal vibrators to minimise packing and crusting in silos.

Hierarchy of control - substitution examples

Substitution involves replacing a hazard or work process with a less hazardous one.

- cleaning walls or surfaces without chemicals (e.g. high pressure water)
- using non-toxic substances instead of toxic ones
- replacing flammable substances with non-flammable ones.

Hierarchy of control - isolation and engineering examples

- blocking service lines such as electrical cables, water pipes
- guarding or securing moving machinery parts such as agitators, fans or blenders
- thoroughly ventilating the space to ensure a safe oxygen level
- expelling stored energy in hydraulic and pneumatic power sources.

Hierarchy of control - administrative examples

- confined space risk assessment
- confined space entry permit
- safety signage and warning signs
- emergency and rescue procedures
- training.

Hierarchy of control - personal protective equipment (PPE) examples

- includes hard hats, glasses, gloves, chemical suits, hearing protection, full body harness, safety boots and respiratory protective equipment
- ideally risks should be controlled through higher order controls e.g. elimination, substitution, isolation or engineering.

Make sure the PPE is appropriate to the job at hand.

When using PPE make sure

- the risk assessment identifies the correct type of PPE needed for the work
- the PPE complies with Australian Standards
- workers required to wear PPE are trained on why it is needed and how to use it correctly
- all PPE is inspected, maintained, repaired and replaced as needed.

Record the risk assessment

A sample risk assessment is provided on page 35.

The completed risk assessment must be reviewed when:

- a new hazard or risk is identified
- conditions at the workplace or the work changes
- a risk control measure does not minimise the risk so far as reasonably practicable
- requested by workers or a health and safety representative
- an incident or injury occurs and before work resumes.

SAMPLE CONFINED SPACE HAZARD IDENTIFICATION CHECKLIST	
Location of confined space	Silo 7
Names of persons completing checklist	Billie Bloggs
Name of competent person	Billie Bloggs
Number of people entering the confined space	2
Description of work	Cleaning grain residue
Date checklist completed	xxxx

Check the box as you identify hazards			
✓	Access (restricted entry and/or exit)		Manufacturing process
✓	Airborne contaminants	✓	Medical emergency – first aid
	Activity/task performed in the space (e.g. use of paints, adhesives, solvents)		Mobile confined space
	Biological hazards (e.g. contact with micro-organisms, viruses, bacteria or fungi associated with a sewer, grain silo)		Noise (e.g. > 85dBA (8 hrs), or 140dB peak)
	Communication		Permits, licenses and registration required, (e.g. asbestos removal)
✓	Crushing, cutting, piercing or shearing of parts of a person's body if exposed to plant such as augers, agitators, blenders, mixers and stirrers		Personal protective equipment – grip is compromised
	Electrical hazards (e.g. potential for electric shock)		Physiological and psychological demands (e.g. physical ability of the person to conduct the work, possibility of a person being claustrophobic, ability to wear the person protective equipment required to do the work (e.g. respirators)
✓	Emergency management (including rescue)		Powered equipment
	Engulfment (e.g. swallowed up or immersed by sand, liquids, grain, animal feed)		Residue left in tanks, vessels etc. or remaining on internal surfaces
✓	Entanglement in moving parts		Restricted movement (e.g. space restricted by size or requirement to wear personal protective equipment)
	Entry of natural contaminants such as groundwater and gases from the surrounding land, soil or strata		Skin contact with hazardous substances which could cause a burn, irritation or allergic dermatitis)
	Environment - dirty		Slip, trip hazards or uneven surfaces
	Environment - wet		Steam, water or other liquids, gases or solids may result in drowning, or being overcome by fumes
	Environment - other (specify) ----------		Temperature extremes (cold)
✓	Fall from a height (e.g. ladders)	✓	Temperature extremes (hot), heat stress
	Fire hazard/naked flame, fire explosion		Uncontrolled introduction of substances
	Guarding/barriers inadequate		Unsafe oxygen level (less than 19.5% or greater than 23.5%)
	Hazardous substances/chemicals		Vertical opening adjacent to or within the confined space
	Hazards outside the confined space		Workplace/surface is unstable or uneven
	Ignition source such as a sparking or electrical tool, including from static on a person being introduced into a space containing a flammable atmosphere		Other .....
	Located near a footpath or road		Other .....
	Lighting inadequate		
✓	Manual handling – lifting, pushing large items of equipment required		Other .....

- This list is not exhaustive, but can be used as the basis of hazard identification
- Attach the completed hazard identification checklist to the risk assessment

SAMPLE CONFINED SPACE RISK ASSESSMENT WORKSHEET			
Location of confined space	Silo 7	**Name and signature of competent person**	B. Bloggs
Date of risk assessment		**Names of other persons completing risk assessment**	J. Case
Description of work	Cleaning grain residue		

Item No	Describe the hazard/risk	Risk level	Describe the risk control
1	Restricted access – difficulty evacuating	Significant	Keep side delivery doors open
2	Grain engulfment	High	Use harness, lifeline and rescue plan
3	Entanglement in moving equipment	High	Isolation of augers/machinery
4	Grain dust, breathing, dust in eyes,	High	Ventilate space and wear PPE (P1 dust mask) Safety glasses No smoking
5	Manual handling, equipment and tools, possible back injury	Significant	Small frequent load, correct lifting technique
6	High temperatures, heat exhaustion/heat stroke	Significant	Frequent work breaks, good hydration, schedule work for early morning
7	Fall from height/ladder – serious injury	Significant	Engage ladder, use harness, lifeline and rescue plan, hard hat
8	Sharp edges – possible cuts to hands	Low	Wear gloves

SAMPLE RISK MATRIX				
	Consequence			
Likelihood	**Death** Catastrophic illness/ injury	**Major** Extensive injuries	**Moderate** Medical treatment required	**Minor** No Injuries
Almost certain Occurred before, expected to occur	High	High	Significant	Significant
Likely Probably will occur	High	Significant	Significant	Significant
Moderate May occur at some time	High	Significant	Low	Low
Unlikely Unusual or rare situation	Significant	Low	Low	Low
High Risk	Immediately cease exposure until protection approved at senior level implemented			
Significant Risk	Procedures alone may not be enough, senior management attention required			
Low Risk	May be management by routine procedures, some risks in category may be acceptable			

Atmospheric testing and monitoring

INTRODUCTION

Testing and monitoring the atmosphere in a confined space is a routine part of identifying hazards and assessing risk. It is also an important part of determining the control measures that are needed to maintain a safe atmosphere.

Direct reading gas detectors (sometimes called gas monitors) are used to test the atmosphere of a confined space. They **must** be operated by a competent person and the gas detector needs to be properly calibrated and maintained.

> **Never trust your senses to determine if the air in a confined space is safe. You cannot see or smell many toxic or flammable gases and vapours, or sense the level of oxygen.**

AIM

Test the atmosphere using a gas detector.

WHAT YOU NEED

- gas detector
- twine
- pole
- colourimetric tube(s) and pump.

WHAT TO DO

Types of gas detectors

There are generally two types of direct gas reading gas detectors on the market for confined spaces: multi gas and single gas. The multi gas detectors will typically analyse the oxygen levels, carbon monoxide, hydrogen sulphide and the flammability of an atmosphere. The single gas detector is designed to monitor for only one gas contaminant e.g. phosphine gas.

Continuous gas detectors

- are recommended as they provide a higher level of safety for workers in the space
- will continuously monitor the atmosphere and alarm if the atmosphere is not safe, alerting workers to evacuate the space
- continuous monitoring involves attaching a continuous gas detector to at least one worker for the duration of confined space entry.

Selecting a gas detector

- you will need to choose a detector that is appropriate for the types of contaminants in the confined space that is to be tested
- not all atmospheric contaminants can be tested with gas detectors, some contaminants may need to be measured using a colourimetric tube (gas drawn through tube containing specific gas sensitive ingredients that change colour in response to the presence of the contaminant of concern and concentration present read off scale on side of tube)
- if you are using colourimetric tubes, there are a variety of brands available, but each tube can only be used in the pump or bellows of its manufacturer
- if you are unsure of which gas detector to select, get advice from a confined space expert.

Follow the manufacturer's instructions

Every brand or make of gas detector is different. Before using any gas detector make sure you have read the manufacturer's operating instructions and you understand how to interpret the results.

Continuous gas detector showing Safe O_2 levels with no atmospheric contaminants detected.

Example of colourimetric tube in manufacturer's bellows (or pump).

What to test for

Before entry into a confined space, test for the following:

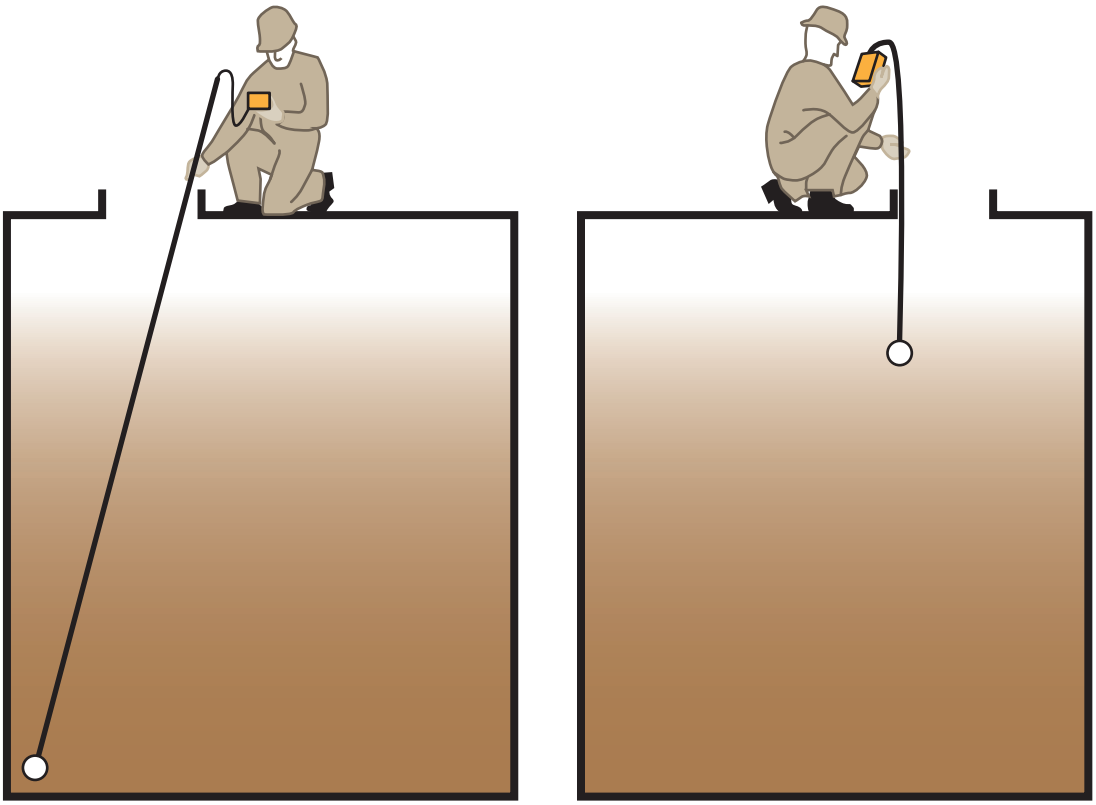
Oxygen content

1. airborne concentration of flammable contaminants (percentage of LEL and UEL). See above photo.
2. airborne concentration of potentially harmful contaminants identified in your risk assessment (e.g. hydrogen sulphide and carbon monoxide).

If you need to enter the space to test remote regions away from entrances or access holes, then air-supplied respiratory equipment should be worn and the entry must be undertaken using a confined space entry permit.

When to test and monitor

- as part of hazard identification and risk assessment and before entry into the confined space
- when there is a change in work
- during work that causes contaminants to be generated in the work space
- before workers re-enter a space if it has been vacated e.g. lunch break, resuming work after an overnight break
- if workers report an odour or feel unwell
- after an injury or incident and before work restarts in the space
- when mechanical ventilation is being used (continuous monitoring).



Atmospheric testing of different regions and levels of a confined space.

Conducting an initial atmospheric test

- initial testing should be done from outside the confined space
- when first opening the confined space position yourself upwind from the opening to prevent inhaling any gases or contaminants that are released on opening.

Confined space with a vertical or top entry

- allow the space to vent for at least 30 minutes before initial testing, longer if the space has not been opened for a long time
- if identified by risk assessment apply mechanical ventilation before testing
- attach a length of twine to the gas detector so that the detector can be lowered into the space (you can only use a gas detector that records maximum and minimum readings in this way as a near hazardous reading may turn to unacceptable by the time the meter is withdrawn from the tank, masking a hazard)
- because contaminants can settle at different levels, each part of the confined space should be tested – side to side and top to bottom. E.g. some gases (such as hydrogen sulphide) are heavier than air and in unventilated areas will settle to the bottom of the space, while other gases (such as methane) are lighter than air and will collect at the top of the space
- testing should be carried out on a sufficient number of points to accurately reflect areas of the space that are likely to be accessed by workers
- test in front of pipes and ducting that enter the spaces for potential gases that may enter the space from a remote location

- some gases may be dissolved in liquids and released when the liquid is disturbed or a crust over the liquid is broken (e.g. organic matter). It may be necessary to agitate liquids before testing
- record the test results.

Confined space with a horizontal or ground level entry

- attach the gas detector to a pole and insert the pole into the space
- test the space using the method outlined above.

Cross sensitivities

- know what additional contaminants you are taking into the confined space as the sensors in your gas detector can sometimes respond to other chemicals, as well as those they are designed to show. This is called cross sensitivity and can either mask the presence of, or give an increased or false indication of the gas of concern
- your gas detector should have a data sheet that identifies these cross sensitivities. When you monitor a confined space keep this in the back of your mind. It is always important to get the correct result as lives depend on it.

Calibration and maintenance of gas detectors

Gas detectors need to be calibrated and maintained as per the manufacturer's instructions.

DO NOT USE a gas detector that is not calibrated or has not been maintained properly. Your life and the lives of others may depend on it.

Example of gas testing a confined space with a vertical entry.

Hiring gas detectors

Gas detectors are available from national hire companies.

- consider hiring gas detectors when you need them to avoid the ongoing costs associated with calibration and maintenance
- when hiring gas detectors check the dates of the last calibration and maintenance to ensure the unit is current and safe for use.

Example of a gas detector kit that is readily available from a National Hire company.

Confined space entry permit

INTRODUCTION

A confined space entry permit takes the information from the risk assessment and provides a formal check to ensure all elements of a safe system of work are in place before you are allowed to enter the confined space.

A confined space entry permit must be issued for each entry into the confined space. Each permit only applies to one confined space and allows one or more workers to enter that space.

A competent person who directs and supervises the work should be nominated and authorised to issue the permit on behalf of the business or undertaking.

A confined space entry permit is also needed when a person enters a confined space to conduct the initial hazard identification or risk assessment. The permit may need to be revised after this is completed.

A sample entry permit is provided on page 42.

AIM

Complete a confined space entry permit.

WHAT YOU NEED

- confined space entry permit template
- completed risk assessment
- competent person(s) who can complete and authorise the permit.

WHAT TO DO

Structure of a confined space permit

They usually have four main parts:

- a list of hazard control measures that must be in place before anyone can enter the space
- 'authority to enter' section that is signed by the competent authorised person
- sign on area for workers and standby person
- withdrawal of consent to enter, indicating that all work is complete and all workers have exited the space.

Complete the entry permit using information from the risk assessment

- identify and record the confined space that the permit applies to
- enter the name of any worker(s) permitted to enter the space and the name of the standby person
- enter the period of time the permit is valid
- record results of atmospheric testing
- indicate the control measures that **must** be implemented before work commences e.g. the isolation of plant and services, purging, ventilation, atmospheric testing, cleaning, signage
- indicate the control measures that **must** be implemented or continued while work is being done in the space, e.g. ventilation, continuous monitoring, respiratory protective equipment and personal protective equipment
- provide a list of equipment to be taken into the confined space, with any exclusions such as ignition sources
- detail emergency response and rescue equipment.

Authorisation

The confined space permit **must** be issued by a competent person who is authorised to do so, on behalf of the business or undertaking.

Displaying the entry permit

- it should be displayed in a prominent place near the space for easy signing and clearance
- each worker **must** be able to understand the permit
- workers are to sign the permit on entry and exit.

SAMPLE CONFINED SPACE ENTRY PERMIT

Location of entry _____Silo 7_____ Authority number: __001 / - 1/6/15___

Purpose of entry: ☐ Inspection ☒ Cleaning ☐ Maintenance ☐ Repair ☐Hot work

☐Other _____

Brief description of Purpose: Cleaning of grain residue_____

Confined Space Equipment and PPE Used During Entry:

☒ Harness/lifelines ☒ Two Way Communications/Type___Verbal__

☐ Rescue Tripod with Lifeline_____

☒ Respirator - Type ___P1_____ ☐ Self-Contained Breathing Apparatus

☒ Footwear - Type __Standard___ ☐ Safety Helmet

☒ Gloves - Type ___Rigger_____ ☐ Protective clothing – Type _____

☐ Hearing protection ☒ Eye protection

☒ Other PPE or Equipment ____Helmet_____

ISOLATION: Have all energy sources been locked and/or tagged? Yes ☒ No ☐

Location of isolation:	Method of isolation:	Time/s:
Auger sweep motor (outside)	De-energise/lockout/tag out	1100

ATMOSPHERIC EVALUATION/TESTING

Does space contain a flammable or combustible gas or liquid? Yes ☐ No ☒ _____

Does space contain dry explosive dusts or ignitable residues? Yes ☐ No ☒ _____

If "yes" is the answer to either of the previous two questions, clean, cover, or remove contaminants so tests show no possibility of flames or sparks igniting dry dusts, residues, or flammable gases or vapours.

Flammable or combustible gases in space and adjacent areas < 5% of the LEL?
Yes ☒ No ☐

Type & S/N of equip-Model: __Altair 4__ S/N: __23157915__ Calibration date: **X / X / XX**

	Opening	Middle	Floor	Other	Safe Limit
% **Oxygen**	20.9	20.9	20.9		**>19.5%&<21%**
% **LEL**	0	0	0		**<5%** of LEL
Toxic	0	0	0		**< TWA**

ATMOSPHERIC MONITORING
(If any "no" answers appear below, entry is not authorised)

	Reading	Time	Within limits	Safe limits
% Oxygen	20.9	1115	Yes ☒ No ☐	> 19.5% & < 21.5%
Carbon Monoxide ppm	0		Yes ☒ No ☐	< 25 ppm
Hydrogen Sulphide ppm	0		Yes ☒ No ☐	< 10 ppm
Flammable gas LEL	0		Yes ☒ No ☐	<5% LEL
Other	–		Yes ☐ No ☐	

OTHER PRECAUTIONS

Warning notices/barricades Yes ☒ No☐ Smoking forbidden Yes ☒ No ☐

Traffic control details Yes ☐ No ☐ ___N/A_____

Are all ventilators and electrical equipment intrinsically safe and approved?
Yes ☐ No ☐ N/A ☒

Any special hazards? Yes ☒ No ☐ ___Fall from ladder – use harness/lifeline

EMERGENCY RESPONSE / PROCEDURES, EQUIPMENT

Is a rescue plan in place/Details? Yes ☒ No ☐ Response time? 10 mins

What could go wrong? Heat stress due to high temperature / fall from ladder

Are First Aid supplies and rescue provisions provided/Details? Yes ☒ No ☐

Spare harness/lifeline/hoist

Capabilities of rescue personnel First aid / basic rescue from height or confined space

Rescuer/First Aider names K Bloggs

Phone/ext # ## #### ####

Other emergency contacts: House ## #### #### or 000

HOT WORK (if applicable)

Type of appropriate fire prevention/equipment used? ____ _

Work area clear of all combustibles? Yes ☐ No ☐

Suitable access and exit? Yes ☐ No☐ Is Hot Work permitted Yes ☐ No ☐

AUTHORITY TO ENTER

The control measures and precautions for the safe entry and execution of the work in the confined space have been implemented and the persons required to work in the confined space have been briefed and understand the requirements of this written authority.

Person in direct control (print) Bill Bloggs

Signature B Bloggs Date: …X… /…X… /…XX…

Time: 1055

This written authority is valid until: Date: …X.. /…X.. /…XX.. Time: 1500

PERSONS AUTHORISED TO ENTER CONFINED SPACE

I have been advised of and understand the control measures and precautions to be observed with the entry and work in the confined space.

Entry			Exit		
Name	Date	Time	Name	Date	Time
J. Case		1100	J. Case		1220

STANDBY PERSONNEL/EMERGENCY REQUIREMENTS

Name	Duty	Name	Duty
Bill Bloggs	Standby		
Karen Bloggs	First Aid / rescue		

WITHDRAWAL OF WRITTEN AUTHORITY

All persons and equipment accounted for Yes ☒ No ☐

Equipment checked, cleaned and stowed correctly Yes ☒ No ☐

Signature _____B Bloggs_____ Date: …X… /…X… /…X… Time: __1200___

Signs and barricades

INTRODUCTION

Before any work relating to a confined space can start, appropriate signs and protective barriers **must** be erected to prevent entry of persons not involved in the work. Barriers also help prevent those operating around the confined space from accidentally falling into a vertical entry confined space.

AIM

To prevent unauthorised access to the work area.

WHAT YOU NEED

- signs
- barrier tape
- safety cones
- temporary protective barriers.

WHAT TO DO

Post warning signs

- signs **must** warn against entry by people other than those who are listed on the confined space entry permit, and **must** be placed at every entrance to the confined space
- signs **must** be in place while the confined space is in use, including when preparing to work in the space, during work in the space and when packing up on completion of the work.

Secure the area

- use barrier tape or safety cones to mark out an exclusion zone around the confined space
- if the space has a vertical entry and there is a risk of workers accidentally falling into the opening consider placing temporary protective barriers around the opening to prevent falls.

Using cones and barrier tape to secure the perimeter of a confined space.

Isolation

INTRODUCTION

All potentially hazardous services should be isolated before any person enters the confined space.

Isolate to prevent:

- the release of liquids and materials into the space via piping, ducts, vents, drains, conveyors
- the start-up of machinery in the space
- the start-up of plant or services outside the space that could create a hazard inside the space
- the release of any stored or potential energy in plant
- the unintended use of electrical equipment.

If liquids, gases or vapours could enter the confined space then the pipe work should be physically isolated.

There is a range of isolation measures that can be used e.g. physically locking, tagging, closing and blanking (blanking involves inserting a solid plate through the cross section of a pipe to stop the flow of liquid or materials).

All isolation measures need to be supported by systems to ensure that the isolation measures are not removed until all work is complete and workers have left the space.

AIM

To isolate hazardous services to protect workers.

WHAT YOU NEED

- isolation procedure
- suitable lock out measures and devices
- danger tags.

WHAT TO DO

Confirm the isolation procedure for the confined space

An isolation procedure is a set of pre-planned steps that should be followed for each confined space entry.

Consider the following lockout process as a basis for an isolation procedure:

- shut down the machinery and equipment
- identify all energy sources and other hazards
- identify all isolation points
- isolate all energy sources
- control or de-energise all stored energy
- lockout all isolation points
- tag machinery controls, energy sources and other hazards, and
- test that isolation is effective by 'trying' to reactivate the plant without exposing the tester or others to risk.

Availability of lockout devices

Various devices are available for locking out energy sources and other hazards that could pose a risk to workers. These include switches with a built-in lock and lockouts for circuit breakers, fuses and all types of valves.

Also readily available are chains and safety lockout jaws (sometimes called hasps), accommodating a number of padlocks and sets of robust safety padlocks. Only devices that incorporate a lock, or can accommodate one or more padlocks, are suitable lockout devices.

Management of keys

When a lock is used, the key should be kept in the possession of the person placing the lock. Spare keys should not be accessible except in emergencies.

Locks and tags

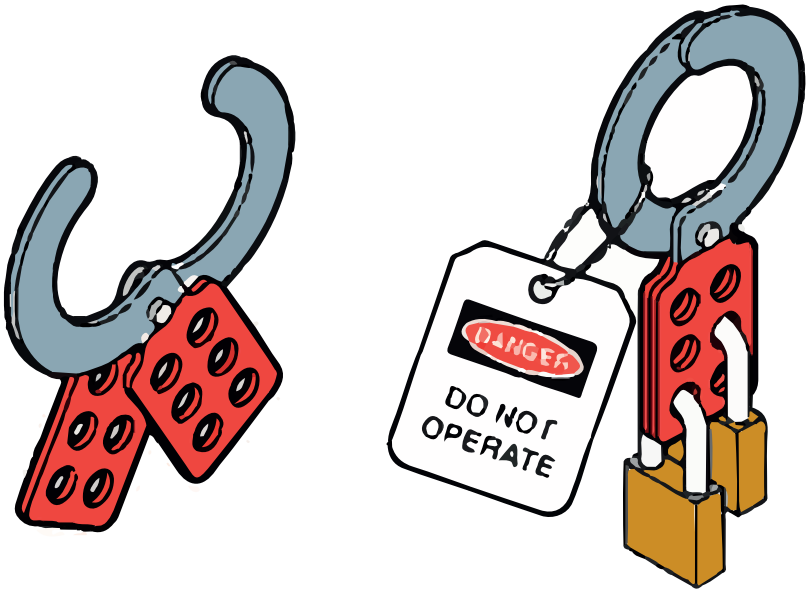
Every person working on isolated equipment should fit their own lock and tag. When using locks and tags, consider the following:

- tags should be dated and signed
- locks should be accompanied by a corresponding tag to identify who has placed the tag
- tags and locks should only be removed by the worker who applied them or by the supervisor after consultation with the signatory on the tag
- locks and tags should be fitted to all isolation points.

Use of danger tags

Danger tags should be attached to an isolator in a visible position whenever the isolator is used to lock out an energy source.

A danger tag on the isolation devices of an item of equipment is a warning that the equipment is in an unsafe condition and that operating that equipment may endanger the person who attached the tag.



Example of tag and lockout with the padlock of two workers.

Example of a danger tag.

Making the atmosphere safe

INTRODUCTION

A safe atmosphere must be ensured, so far as is reasonably practical during work in a confined space. A safe atmosphere in a confined space is one that:

- has a **safe oxygen level** (19.5% to 23.5%)
- is **free of airborne contaminants** or any airborne contaminants are in concentrations **below** their allowable exposure standard
- any flammable gas or vapour in the atmosphere is at concentrations **below 5% of its LEL**. E.g. the LEL of methane is 5%, a safe entry limit is 5% of the LEL so to enter the confined space a reading of .0025% is needed.

A safe atmosphere can be achieved within the confined space by ventilation. Ventilation may be used to bring clean air into a space (blow) or exhaust (suck) contaminated air out of a space.

AIM

Ventilate a confined space.

WHAT YOU NEED

- gas detector
- industrial fan or blower
- mechanical ventilation equipment.

WHAT TO DO

Natural ventilation

This means opening the doors, hatches, lids, etc. on the confined space and letting the space ventilate with fresh air from outside the space.

The success of natural ventilation in achieving a safe atmosphere depends on:

- the size and structure of the space
- number, size and location of openings to allow ventilation
- the type of contaminant in the space. E.g. if the space has only a top opening and you are trying to ventilate a gas that sinks to the bottom such as hydrogen sulphide then natural ventilation may not ensure a safe atmosphere
- industrial fans or blowers positioned at space openings can assist natural ventilation
- always confirm the presence of a safe atmosphere through atmospheric testing using a gas detector.

Mechanical ventilation

Mechanical ventilation **must** be used if a safe atmosphere cannot be achieved through natural ventilation.

Mechanical ventilation involves using fans, blowers, extraction devices and ducting to blow air into the space or extract (suck) air from the space, or a combination of both.

Blower and extractor fan with ribbed ducting. The ducting is attached to the fan before use.

Using mechanical ventilation

If mechanical ventilation is required seek advice from a confined space expert to work out:

- number of fans, blowers, extractors
- length of ducting needed
- ventilation flow rate (this is the number of times the atmosphere is to be replaced in the space per hour)
- correct placement of ventilation equipment
- if continuous ventilation is needed
- if intrinsically safe fans, blowers, extractors are needed to prevent risk of explosion if removing flammable gases.

Purging

- purging involves using an inert gas, such as nitrogen to clear flammable gases or vapours from a space before work in the space begins
- the space is then thoroughly ventilated to remove the inert gas
- purging with an inert gas (e.g. nitrogen) is **DANGEROUS** as it displaces oxygen
- purging requires specialist skills and equipment to be completed safely
- if purging is needed then seek advice from a confined space expert.

Flammable gases and vapours

- if continuous flammable gas detectors and supplied air respiratory equipment is used, workers may remain in a confined space at concentrations of up to 10% of the LEL
- at 10% or above the LEL workers must immediately evacuate the space.

Use of combustion engines

- **never put a combustion engine** (e.g. pumps, generators and compressors) inside a confined space
- combustion engines consume oxygen and create carbon monoxide which can be **DEADLY**
- use electrically or pneumatically powered equipment instead
- combustion engines used outside the space need to be located so their exhaust emission **do not enter** the space.

Where mechanical ventilation is used to set up and maintain a safe atmosphere then the atmosphere must be continuously monitored i.e. continuous gas detector worn by at least one worker.

Fire control

INTRODUCTION

Fires in a confined space react differently to those in open atmosphere. They provide an extremely high level of hazard, unless the fire is small and you can quickly smother it with a fire blanket or with several buckets of sand. If this is not possible you should leave the space immediately and fight the fire from outside the space.

AIM

Prevent and control fire.

WHAT YOU NEED

- fire blanket
- buckets of sand
- fire extinguisher(s)
- mechanical ventilation.

WHAT TO DO

Flammable atmosphere

Where a flammable atmosphere may exist in a confined space and there is a risk of fire and explosion, **ignition sources must be eliminated.**

Examples of possible ignition sources inside and outside the space include:

- hot surfaces and open flames, such as welding torches, matches or cigarette lighters
- electrical arcing from incorrectly installed wires or electrically overloaded fittings
- combustion engines
- metal tools striking metal surfaces
- spark-producing equipment e.g. grinding wheels
- static electricity sparks e.g. generated from synthetic clothing
- sparks or heat produced from non-intrinsically safe electrical equipment e.g. mobile phone, radio, and flashlight.

Managing hot work

Hot work includes welding, thermal or oxygen cutting and heating. Hot work must not be done in a confined space with a flammable atmosphere.

In a non-flammable atmosphere additional controls need to be put in place to prevent the ignition of combustible materials. These include:

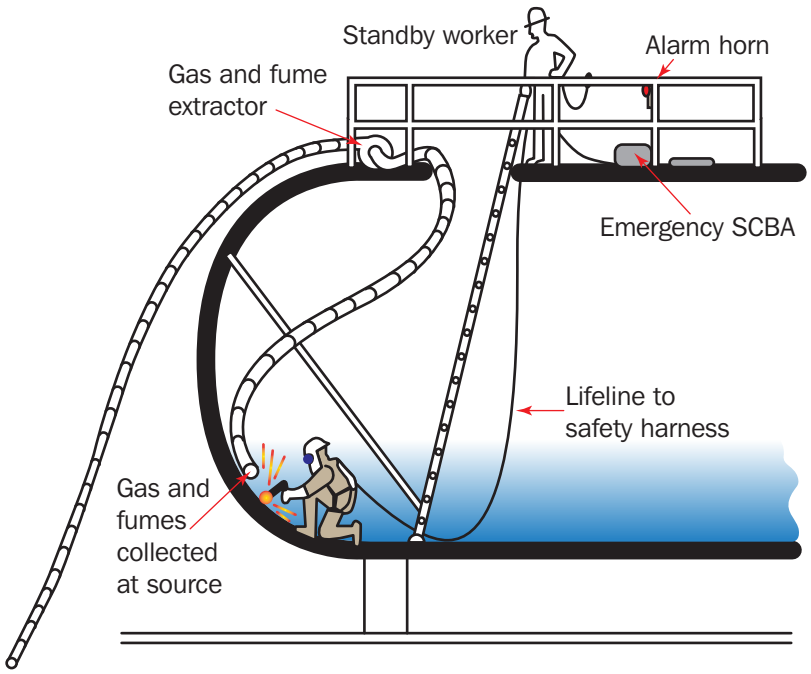
- removal of all combustible substances, including dry residues from the space before hot work commences e.g. organic matter
- if combustibles cannot be removed cover them with a fire blanket or other means to prevent ignition from sparks or heat
- not allowing compressed gas cylinders to be located in the space.

Fumes from hot work

In addition to a fire risk hot work can make the atmosphere unsafe for breathing:

- hot work may reduce the oxygen concentration of the atmosphere
- the coatings of surfaces under hot work may release toxic or flammable contaminants
- mechanical ventilation should be provided with an exhaust suction point as close as possible to the hot work to maintain a safe atmosphere.

Welding in a confined space showing gas and fumes being collected at the source.



Putting out a fire

The choice of an extinguishing agent will depend on the substance burning. The solution may be as simple as closing the door or hatch on the confined space and waiting for the fire to smother.

If fighting the fire from outside the space, the fire will have changed the atmosphere of the confined space and will add carbon dioxide, carbon monoxide, hydrogen chloride if PVC fittings are present and a variety of other hazardous substances depending on materials and coatings used inside the confined space.

The use of extinguishing agents may also create new hazards that need to be considered:

- water can produce steam and if electricals are not isolated may cause short circuits and possibly act as a conductor of electricity in the space
- dry chemical will reduce visibility and the powder is highly irritating
- some extinguishing agents can reduce oxygen levels and may make additional hazardous substances
- the wet chemical extinguisher releases alkaline chemicals which may be irritating to eyes and skin.

Types of extinguishing agents

Portable fire extinguishing equipment is designed to provide first attack to a small fire during its initial stage. When deciding to attack a fire, the standby person should raise the alarm and start the emergency procedure. Do not fight a fire if it is not safe for you to do so. Evacuate the space.

COMMONLY USED EXTINGUISHING AGENTS

Foam
- red in colour with a blue band, it contains aqueous film-forming foam (AFFF) additive
- for use on flammable liquid fires such as petrol, oils and paint
- **must never be used on fires involving live electrical equipment**

Fire bucket
- bucket filled with water or sand
- cheap, reliable, easy to use and can be quickly refilled
- effective for small fires
- sand is good for absorbing flammable liquids, reducing risk of ignition

Carbon Dioxide
- red in colour with a black band,
- for use on fires involving flammable liquids and live electrical equipment

Fire blanket
- comes in variety of sizes
- effective for small fires
- used to cover and cut off supply of oxygen

Dry Chemical
- red in colour with a white band, it contains a bi-carbonate based powder
- for fires involving flammable liquids and live electrical equipment

Water
- red in colour, it contains water under pressure
- for use on carbonaceous solids such as wood, paper, rubbish or textiles
- water extinguishers are unsuitable for flammable liquid fires
- **must never be used on fires involving live electrical equipment**

Vaporising liquid (halon)
- red in colour with a yellow band, it contains a vaporising liquid
- suitable for fires involving live electrical equipment

After a fire

- the atmosphere of the confined space will be different and must be retested before any re-entry is attempted
- new contaminants from some types of fire extinguishers may now be coating the inside of the space that you may need protection from
- you must review the risk assessment before re-entry (this may trigger a new confined space permit) and in doing so, consult the Safety Data Sheet (SDS) for the fire extinguisher you've used to identify if extra personal protective equipment or specialised gas testing is now necessary before re-entry
- the SDS will also help identify the best way to get rid of the material from the extinguisher that may now be coating the space.

Respiratory protective equipment

INTRODUCTION

The type of respirator you may need will depend on what gas or airborne contaminant you need to be protected from. This should be identified in the risk assessment.

It is important that respirators are fitted correctly. If a respirator leaks it does not protect.

AIM

- Select and correctly fit a respirator.

WHAT YOU NEED

- Respirator as per the risk assessment.

WHAT TO DO

Wear a respirator when

It is identified in the risk assessment and permit as a risk control measure.

A respirator **must** be worn:

- if you cannot ensure a confined space has safe levels of airborne contaminants (under the TWA level)
- where there is no exposure standard for the substance, or where the substance is present in an unknown quantity.

Types of respirators

There are two basic types of respirators.

- air purifying respirators, and
- air supplying respirators.

Type 1: Air purifying respirators

They remove contaminants from the air when inhaling. **They are not suitable for use in an oxygen-deficient atmosphere.** There are several different types.

Disposable mechanical filter respirators

- these are often called dust masks or particulate respirators
- they are designed for use against dust, mists and fumes and some gases
- they consist of a shaped piece of filter material held by two straps to the wearer's head
- when the mask loses its shape or when breathing resistance becomes too great the respirator should be discarded.

Cartridge filter respirators

- remove the same airborne particles as do the disposable respirators
- filters in these respirators are replaceable and the face pieces are made to last a long time
- filter life is generally greater than that of the one-piece disposables.

Fitting a disposable mechanical respirator

Consider the steps below to get a good face fit.

1. hold the respirator in one hand with the nose piece at your fingertips, allowing the head straps to hang below your hands
2. place respirator against your face with the nose piece on the bridge of your nose and place the top strap high on the back of your head.
3. move the bottom strap over your head and position it below your ears, use both hands to mould the nose-piece to the shape of your nose for a secure and comfortable fit
4. test to fit, cup your hands over the respirator and exhale strongly. If air flows around your nose, tighten the nose-piece. If air escapes around the edges, reposition the straps for a better fit.

Do not have beards or other facial hair that prevent a good seal between the face and the face seal of the respirator.

Chemical cartridge respirators

- these protect against gases and vapours
- they have one or two chemical cartridges containing a sorbent that adsorbs specific gases and vapours
- many different cartridges are available against specific gases or
- vapours.

Gas masks

These also protect against gases and vapours but have replaceable canisters that are larger than cartridges.

Fitting a half face (mask) respirator

Consider the steps below to get a good face fit.

1 place the respirator over the mouth and nose. Pull the harness over the crown of the head

2 hook bottom straps together behind your neck

3 tighten the top and bottom strap to create a secure fit. Do not over tighten

Positive pressure face fit check

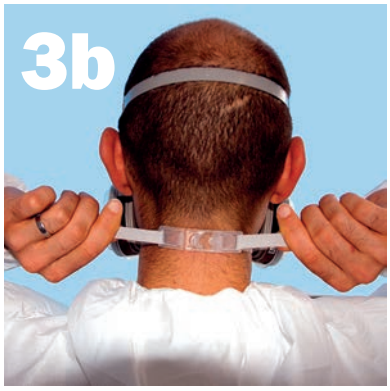
4 Place the palm of your hand over the exhalation valve cover and exhale gently. If the face piece bulges slightly and no air leaks are detected between the face and the face piece, a proper seal has been obtained

Negative pressure face fit check

5a. **with cartridge.** Place the palms of your hands over the cartridges to restrict the air flow. Inhale gently. The face piece should collapse slightly

5b. **with particulate filters – disc style** Place your thumbs onto the centre of the filters to restrict the air flow. The face piece should collapse slightly

5c. **with solid top particulate filters** Squeeze filter covers together using the palms of your hands and fingers to restrict airflow. Inhale gently. The face piece should collapse slightly.



If air leaks between the face and the face seal of the respirator, reposition it and adjust the steps for a tighter seal. Repeat steps 4 and 5.

Maintaining cartridge type purifying respirators

- remove respirator filters when cleaning
- the face piece and valves can be washed in soap and warm water rinse well, dry with a clean cloth and leave to air in a well ventilated area out of direct sunlight
- wipe the outside surface of respirator
- keep goggles and headband clean as the headband is particularly prone to absorption of chemicals
- the cleaned respirator can be stored in a sealed plastic bag out of direct sunlight
- regularly check the one-way valves on your respirator to make sure they are still functioning
- change and use filters according to the manufacturer's recommendations.

Type 2: Air supplying respirators

Air supplied respirators are designed to allow the wearer a continuous supply of clean air from either a cylinder or a pipe connected to an air-line, compressor or surface supply hose.

They are used when there is an unsafe atmosphere or during the rescue of worker(s) who are overcome by an unsafe atmosphere.

Self-contained breathing apparatus (SCBA)

SCBA is a common form of an air supplied respirator used in confined space work.

Using SCBA

Every brand or make of SCBA has different operating instructions. Before using SCBA make sure you have read the manufacturer's instructions and have been trained in SCBA use.

SCBA sets are composed of four main elements:

- **Back pack.** This is used to hold the air cylinder on the user
- **Cylinder.** There are several types of cylinders that are commonly used. Aluminium fibre wrapped cylinders, full carbon fibre cylinders and steel

Four elements of SCBA.

- **Lung demand valve.** These are connected to the back pack and mask
- **Mask.** The mask directs the flow of air either into the user's lungs or exhales the user's breath back into the environment.

Maintenance of SCBA

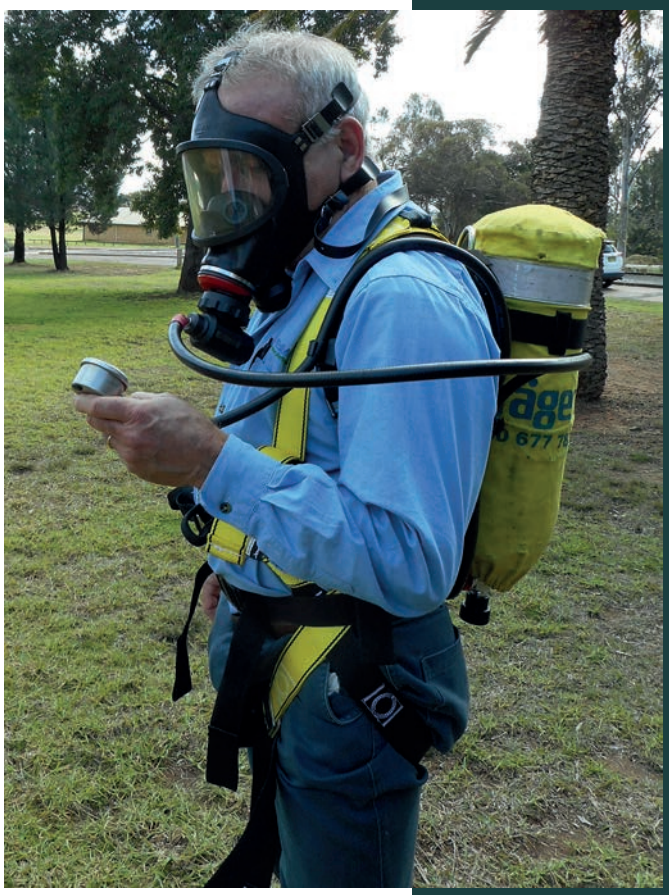
SCBAs need to be serviced by a technician every year. They require an overhaul every six and twelve years. The SCBA set needs to be checked routinely every week, and before use.

Cylinders require hydrostatic testing every three years for aluminium and carbon fibre and every five years for steel cylinders.

Operation and maintenance of SCBA must always be completed as per the manufacturer's instructions.

Other personal protective equipment (PPE)

All PPE identified in the risk assessment must be worn. Examples of other PPE include safety glasses, goggles, hearing protection, full body harness, safety boots, helmet, chemical suits, and gloves.



Worker wearing correctly fitted SCBA – side and rear view.

Standby person

INTRODUCTION

NEVER WORK ALONE IN A CONFINED SPACE

Before you can enter a confined space, **a standby person must be assigned outside the space** to continuously monitor the health and safety of those inside the space. If practicable they are to observe the work being carried out and take appropriate emergency procedures when necessary.

A communication system is needed to enable communication between people inside and outside the confined space and to summon help in an emergency. Communication can be achieved by voice, radio, hand signals or other suitable methods.

AIM

To perform the duties of a standby person.

WHAT YOU NEED

- a standby person
- agreed communication method
- all required rescue equipment available at the entry point.

WHAT TO DO

The standby person should:

- always monitor the space and occupants
- know who is in the space at all times
- not allow unauthorised persons to enter the space or occupy an area adjacent to the space that may introduce hazards
- maintain communications with those in the space at all times
- have the authority to order workers to exit the space if any hazardous situation arises
- not remove any means of exit until all workers have left the space
- lower tools into the space if required and only if it is safe to do so
- **remain outside** the confined space and do no other work which may interfere with their main role of monitoring the workers inside the space
- have all required rescue equipment (e.g. safety harnesses, lifting equipment) immediately available
- use retrieval equipment to begin a rescue if possible
- **never enter** the space to attempt rescue
- have all the competencies required to work in a confined space and gas test a confined space atmosphere.

Possible communication methods based on the quality of sight and sound

Method	Sound/sight of standby person
1. Verbal with agreed hand signals or whistle back up	Good
2. Agreed hand signals with whistle back up	
3. Two way radio with agreed hand signals or whistle back up	
4. Hardwire or wireless systems with whistle back up	Restricted
5. Use of rope signals – the OATH method	

Whistle code:
One blast = OK / proceed
Two blasts = Stop / wait
Continuous = Evacuate

Rope signals
1 tug = **O**K. Can be to ask if OK and to answer
2 tugs = **A**dvance. ie give me rope
3 tugs = **T**ake up rope. I'm coming back
4 tugs = **H**ELP).
Note: Four pulls on the rope means Help!

Make sure you have your communications sorted out BEFORE the confined space is entered.

Rescue equipment

All rescue equipment should be kept in close proximity to the confined space so that it can be used immediately.

Do not use rescue equipment or attempt to rescue others unless you have received the proper training.

INTRODUCTION

There are three basic types of confined space rescue:

- **self-rescue**, where an injured worker exits the space under their own power or with some assistance from others
- **non-entry rescue**, where the rescue is completed from outside the space, and
- **entry rescue**, where rescue personnel enter the space to retrieve an injured person.

For each type of rescue there is a range of rescue equipment that is needed to safely rescue worker(s) from a confined space. Always confirm rescue equipment requirements through risk assessment. Other equipment that is not listed here may be required.

Each confined space has unique characteristics and hazards. The rescue equipment needed for a particular confined space entry should be identified during risk assessment and implemented in emergency procedures. The rescue equipment needed for one confined space entry may be different from another confined space.

This chapter provides examples of commonly used confined space rescue equipment.

AIM

Have correct rescue equipment available for immediate use.

WHAT YOU MAY NEED

- full body harness (confined space)
- ropes
- spreader bar
- tripod, davit arms
- connecting devices, e.g. carabiners, lanyards
- retractable lifelines
- self-contained breathing apparatus
- personnel rated hoist
- first aid kit.

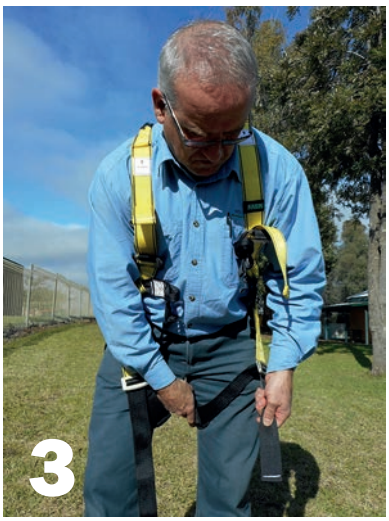
WHAT TO DO

Full body harness – confined space

- a full body confined space harness should be worn by all workers (and rescuers) who enter a confined space
- a confined space harness is different from a ‘falls’ harness in that it has lifting attachments on the shoulder straps
- a harness is needed for fall prevention or arrest (for spaces with a vertical entry which have potential for falls) and to provide attachment points for rescue
- always check the inspection date on the harness before use. Do not use the harness if it has passed its inspection due date.

How to put on a harness

- **Step 1.** Hold harness by back D-ring. Shake harness to allow straps to fall in place. Check for signs of wear or damage **Never use a damaged harness**
- **Step 2.** Place arms through shoulder straps and slip straps over shoulder so D-ring is located in middle of your back between the shoulder blades
- **Step 3.** Pull leg strap between legs and connect to opposite end. Repeat with second leg strap
- **Step 4.** Adjust leg straps. Ensure there are no twists and a fist cannot be made under the leg straps
- **Step 5.** Connect chest strap and position mid-chest area. Tighten to keep shoulder straps taut
- **Step 6.** After all straps have been buckled, tighten all buckles so that the harness fits snug but allow full range of movement. Pass excess strap through loop keepers.



(Above) If harness is fitted correctly you should be able to reach the D ring (circled in red).

(Right) Kernmantle rope used in confined space rescue.

Ropes

Kernmantle rope is used for rescue. Kernmantle has a breaking strain of around 3400 kg for 11 mm and safe working load of around 300 kg. Rescue kernmantle must be between 11 mm and 16 mm in diameter.

Before use check the following:

- rotate the rope lanyard and inspect from end to end for fuzzy, worn, broken or cut fibres. Weakened areas have noticeable changes in the original rope diameter
- replace when the rope diameter is not uniform throughout (following a short break-in period)
- the older a rope is and the more use it gets, the more important testing and inspection become.

Fall protection needs for confined space

Injuries sustained from a fall into a confined space can be as serious as a fall from a work platform above ground level.

In fact, confined spaces such as holding tanks, manholes, etc. often have access holes that range from one to five metres deep. Proper personnel fall arrest and retrieval equipment is needed for safe entry/exit and safe rescue.

A fall protection and retrieval system for confined spaces consists of three major elements:

- properly fitted full body harness
- fall arrest device (e.g. retractable lifeline)
- suitable anchorage and connector (e.g. tripod or davit).

Tripods, davit arms and connecting devices

Fall protection and retrieval equipment, such as a full body harness attached to a retractable lifeline that is connected to a personnel-rated hoist mounted on a tripod or a davit arm, help make confined space entry and 'external rescue' possible without unnecessary risk. Connecting devices are required to attach the worker to an anchorage point e.g. carabiner.

Retractable lifelines

Retractable lifelines are alternative connecting devices to shock-absorbing lanyards.

Retractable lifelines are recommended:

- they allow workers to enter a confined space under their own power
- they allow the worker freedom of movement while keeping the lifeline out of their way
- should a fall occur, a centrifugal locking mechanism quickly stops the fall
- in an emergency, the standby person may use retractable lifelines to raise a worker to safety from outside the confined space.

Anchorage points

- are secured points for the attachment of lifelines and hoists
- for the majority of vertical entry confined space applications, a tripod or davit serves as a proper anchorage point
- most tripods and davits are designed to support up to a 5,000 kg static load
- always check the anchorage point before use.

Lanyards

There are many different types of lanyards available. They can be rope, webbing or wire and can be fitted with combinations of hooks, energy absorbers and carabiners.

Examples of commonly used lanyards for confined space fall protection.


Carabiner

Retractable shock absorbing lanyard


Shock absorbing lanyard


Twin tail shock absorbing lanyard

Tripods

When setting up a tripod check:

- inspection date/ tag
- if it is in good working order
- load capacity of the unit
- base chain or rope is adjusted correctly
- it is at the correct height for the task
- whether it needs to be secured
- if the connecting device is over the access hole.

Remove the tripod from the carry bag and attach the connecting device to the tripod (in this case a carabiner).

Expand legs so that the set up height allows the connecting device to be at a suitable height above the load and then insert holding pins in legs and tighten base straps.

Attach personnel-rated hoist to the tripod.

Attach hoist to connector on tripod and make any final adjustments to tripod height.

Position tripod over confined space entry point.

Attach a shock absorbing lanyard to worker's harness.

Worker or Standby Person lowering worker into vertical entry confined space.

View of worker descending into a confined space attached to shock absorbing lanyard connected to a personnel-rated hoist mounted on a tripod.

Davit

Using a davit is similar to using a tripod. A davit provides an anchor point for the attachment of lifelines and hoists. When using a davit check:

- inspection date
- if it is in good working order
- load capacity of the unit
- it is at the correct height for the task
- if the connecting device is over the access hole.

Standby person lowering worker into a confined space using a davit arm and winch.

Spreader Bar

A spreader bar is attached to the shoulder attachment points located on the shoulder straps. It is used for the rescue of an unconscious worker. It works by holding the arms above the head of the unconscious worker to keep their airways open while being rescued.

Spreader bar.

Correctly fitted spreader bar on worker.

Rescue simulation of unconscious worker using spreader bar attached to retractable lifeline and tripod.

Self-contained breathing apparatus

This is covered in the chapter on respiratory protection and must be worn by rescue personnel to rescue worker(s) who have been overcome by a lack of oxygen or airborne contaminants.

First aid kit

A first aid kit should be included in your rescue equipment. The equipment and materials in the first aid kit should match the types of potential injuries that are identified in the risk assessment.

Maintenance of rescue equipment

Always follow the manufacturer's instructions for inspection and maintenance of rescue equipment. Some rescue equipment may need to be inspected and certified by an equipment expert.

Consider creating an inventory of confined space equipment

If you own your own rescue equipment you will need to track:

- the types of maintenance and certifications needed
- calibration records (gas detectors)
- dates these were completed
- maintenance records
- details of who completed them, and
- date(s) of future maintenance, and certifications.

Hire of rescue equipment

The majority of the equipment listed in this chapter can be hired through a national hire company.

A basic rescue kit (non-vertical entry) is also readily available containing:

- two full-body confined space harnesses
- spreader bar
- tie off adapter/sling
- rope and pulley (alternative to retractable lifeline and personnel-rated hoist).

This comes in a duffle bag or a plastic box for ease of handling.

Gas detectors, tripods, davits and SCBA can be also hired from a National Hire company.

Basic rescue kit for non-vertical confined space entry available from a National Hire company.

The confined space entry

INTRODUCTION

The previous chapters have focused on getting all the necessary risk control measures (as listed on the confined space entry permit) in place so you can safely enter and work in the confined space.

All first aid, firefighting and rescue equipment should be positioned near the confined space entry point for easy access.

Remember, each space is different and the preparation for entry will be different as well.

AIM

Enter and work safely in a confined space.

WHAT YOU NEED

- equipment and tools to conduct the work
- personal protective equipment as per risk assessment
- harness
- cleaning tools e.g. shovel, broom
- water and detergent
- access to storage areas.

WHAT TO DO

Before entry

- review the risk assessment and the entry permit
- make sure you understand the controls that are needed to work safely in the space
- ensure the area is signed and barricaded to control entry into the work area
- have all the equipment and tools needed for the work near the confined space entry for ease of access
- check equipment and tools for serviceability; rectify or report any faults
- know the emergency procedure
- standby person is allocated for the duration of work
- confirm communication methods with the standby person
- confirm the atmosphere is safe for entry
- put on harness
- put on all PPE as identified in the entry permit
- wear continuous gas detector (when required)
- sign entry permit before entry, but only if it has been completely filled in
- permit to be placed near entry
- enter and exit the space as per method in the entry permit.

Conduct work

- conduct work as per risk assessment and maintain permit controls
- maintain communications with the standby person
- follow all instructions of the standby person.

Dealing with new hazards

- report any new hazards or change in work as soon as recognised to the standby person
- the risk assessment must be reviewed to check whether new controls are needed
- you may be instructed to exit the space until new controls are put in place.

Evacuate the space

- if the continuous gas tester alarms
- when instructed by the standby person
- if you suddenly feel faint, dizzy, breathless, unwell or notice an unknown or unexpected odour.

Emergency response

- immediately alert the standby person if something is wrong
- follow the emergency procedure.

Exiting the space

Each time you enter and exit the space, sign the entry permit.

Finishing work in the confined space

- recover all tools and equipment
- clean up any materials or waste in the space
- conduct inspection of space to ensure work has been completed properly and all materials/waste have been removed
- secure access to the confined space
- remove lockout and tagging
- clear work area, dispose of or recycle waste
- remove and clean PPE
- return PPE and rescue equipment to storage
- return tools and equipment to storage
- remove, store barriers and signs
- complete entry permit
- review the risk assessment and see if any new hazards not previously recognised have been identified during the work and need to be added next time the work is done
- store the completed permit and risk assessment as a record.

Preparation is key in entering a confined space.

Keeping records

INTRODUCTION

The Work Health and Safety Regulation requires that certain records of confined space entry are kept.

AIM

Comply with record keeping requirements.

WHAT YOU NEED

A secure place to store records.

WHAT TO DO

Keep the following records

- confined space risk assessment (until at least 28 days after the work is completed)
- entry permits (at least until the work is completed)
- in the event of a notifiable incident (reporting to the Work Health and Safety Regulator e.g. WorkCover NSW), both the risk assessment and the permit must be kept for at least two years after the incident
- records of all training provided to workers for confined space must be kept for two years.

Allow access to records

Risk assessments and entry permits must be available to any relevant worker on request for the period they are kept.

Glossary

Airborne contaminant	a contaminant in the form of a fume, mist, gas, vapour or dust, and includes microorganisms
Atmospheric monitoring	the continuous monitoring of oxygen levels for any variation and for presence of atmospheric contaminants (combustible or toxic)
Atmospheric testing	the testing at regular intervals of time, which is not continuous, of oxygen levels and any atmospheric contaminants
Breathing apparatus	a device that supplies breathable air for use in areas with high levels of airborne contaminants or unbreathable atmospheres
Colourimetric Tube	a tube generally made of glass for measuring the concentration of a known gaseous contaminant in the air, by drawing a set volume of gas through the tube after breaking the sealed ends. The tube has a scale and the chemicals inside the tube change colour in response to the gas they are sensitive to, to produce a stain that can be read against a scale on the outside of the tube, which provides an indication of the level of that contaminant present in the air
Competent person	a person who has, through a combination of training, education, assessment and experience, acquired knowledge and skills to correctly perform a specified task
Contaminant	means any substance that may be harmful to health or safety
Control measure	in relation to a risk to health and safety, means a measure to eliminate or minimise the risk
Engulfment	the immersion or envelopment of a person by a solid or liquid (e.g. grain, sugar, flour, sand, coal, fertiliser and other substances in a powder or granular form) that is stored within the confined space
Entry	by a person into a confined space, means the person's head or upper body is in the confined space or within the boundary of the confined space
Exposure standard	an exposure standard in the Workplace Exposure Standard for Airborne Contaminants
Fall arrest system	plant or material designed to arrest a fall
Hazard	a situation or thing that has the potential to harm a person. Hazards at work may include: noisy machinery, a moving forklift, chemicals, electricity, working at heights, a repetitive job, bullying and violence at the workplace
Hot work	welding, thermal or oxygen cutting, heating, including fire-producing or spark-producing operations that may increase the risk of fire or explosion
Lower explosive limit (LEL)	the concentration of a flammable contaminant in air below which the propagation of a flame does not occur on contact with an ignition source
Must	indicates a mandatory requirement under the Work, Health and Safety Act and or Regulation

Peak limitations	peak limitations are airborne concentrations of a substance that should not be exceeded even for an instant during any part of the workday
Person conducting a business undertaking (PCBU)	is a legal term under WHS laws for individuals, businesses or organisations that are conducting business. Examples include public and private companies, partners in a partnership, sole traders and self-employed people, government departments, associations (if they have one or more employees)
Personal protective equipment (PPE)	equipment or clothing used by a person to minimise exposure to specific hazards that may result in short-term (acute) or long-term (chronic) physical health problems
Reasonably practicable	means doing what is reasonably able to be done to ensure the health and safety of workers and others
Risk	the possibility that harm (death, injury or illness) might occur when exposed to a hazard
Risk control	taking action to eliminate health and safety risks so far as is reasonably practicable, and if that is not possible, minimising the risks so far as is reasonably practicable. Eliminating a hazard will also eliminate any risks associated with that hazard
Safe oxygen range	a concentration of oxygen in the atmosphere having a minimum of 19.5% volume and a maximum of 23.5% by volume, under normal atmospheric conditions
Short-term exposure limit	the airborne concentration of a substance averaged over a fifteen-minute period. It should not be exceeded at any time or for more than four periods during a normal eight-hour day. A minimum of 60 minutes should be allowed between successive exposures
Standby person	a person assigned to continuously monitor the wellbeing of those inside a confined space, if practicable they observe the work being carried out and initiate emergency procedures when necessary
Time weighted average	the average concentration of a substance when calculated over a normal eight-hour day
Upper explosive limit (UEL)	the concentration of a flammable contaminant in air above which the propagation of a flame does not occur on contact with an ignition source
Worker	a person is a worker if the person carries out work in any capacity for a person conducting a business of undertaking, including, an employee, contractor or subcontractor, employee of a contractor or subcontractor, employee of a labour hire company, an outworker, apprentice or trainee, work experience student, volunteer

The terms used in the glossary have been sourced from the NSW Work Health and Safety Regulation and the Australian Standard AS 2685-2009 Confined spaces.

Legislation

The specific requirements for confined spaces are located in the NSW Work Health and Safety Regulation 2011, *Part 4.3 – Confined spaces.* The requirements are summarised below and exclude requirements of designers, manufacturers, importers and suppliers.

Specific legislative requirements for confined space		
Managing risks associated with confined spaces (PCBU)	The person conducting a business or undertaking (PCBU) must manage the risks associated with entering, working in, working on, or working in the vicinity of a confined space, including the risk of a person inadvertently entering the confined space	WHS Regulation, s66(1)
Risk assessment by a competent person	The PCBU must ensure that a risk assessment carried out for the purpose of managing risks associated with confined spaces is: • done so by a competent person • recorded in writing • reviewed and revised by a competent person as required to reflect any review of control measures, and • has regard to the matters listed in s66(4) of the WHS Regulation	WHS Regulation, s66(2), (3), (4) and (5)
Requirement for a confined space entry permit	The PCBU must not direct a worker to enter a confined space unless that person has a confined space entry permit for the work	WHS Regulation, s67
Confined space entry permit requirements	A confined space entry permit must: • be completed in writing by a competent person • state the confined space to which the permit relates • state the names of the persons permitted to enter the space • state the controls to be implemented • include space to record that work in the space has been completed and that all persons have left the space	WHS Regulation, s67(2)
Control measures to be based on risk assessment	The control measures stated on a confined space entry permit must be based on a risk assessment carried out by a competent person (see s66) and must include controls for safe entry and a safe system of work	WHS Regulation, s67(3)
Completion of work in a confined space	The PCBU must ensure that when work for which an entry permit has been issued is completed all workers leave the space and a competent person makes the appropriate record on the permit (see s67(2))	WHS Regulation, s67(4)

Confined space signage	The PCBU must ensure that signs are erected in a clear and prominent location next to each entry into a confined space that identify the space and inform workers that they must not enter without a permit. The signs must be erected: • while work is being done in preparation for work in the space • immediately before work in the space commences • while the work is being carried out, and • while the work is being completed	WHS Regulation, s68
Communication and safety monitoring	The PCBU must provide a system of work that includes: • continuous communication between workers inside and workers outside the confined space • monitoring of conditions inside the confined space by a standby person who is in the vicinity of the space and, if practical, observing the work	WHS Regulation, s69
Specific controls for confined spaces	The PCBU must manage specific risks associated with: • the introduction of any substances or condition by any connected plant or substance (e.g. exhaust) • the activation or energising of any connected services (e.g. electrical) • contaminants in the atmosphere of the space, including the purging or ventilation of the contaminant • oxygen levels within the space • any flammable gases and vapours • any ignition sources within the space that may case fire or explosion	WHS Regulation, s70, s71, s72 and s73
Emergency procedures	The PCBU must establish and practise first aid and rescue procedures to be followed in the event of an emergency in a confined space	WHS Regulation, s74(1)
First aid and rescue procedures	The PCBU must ensure that first aid and rescue procedures: • are initiated from outside the confined space • the entry and exit openings are large enough to allow emergency access • the entry and exit openings are not obstructed • plant, equipment and personal protective equipment (PPE) provided for first aid and rescue procedures are maintained in good working order	WHS Regulation, s74(2) and (3)
Personal protective equipment (PPE) in emergencies	The PCBU must ensure that suitable PPE is provided to workers required to enter a confined space in the event of an emergency to perform first aid or carry out a rescue. For example, air supplied respiratory equipment is provided where the atmosphere in the confined space contains harmful concentrations of contaminants or unsafe levels of oxygen	WHS Regulation, s75
Records to be kept	Confined space risk assessments and entry permits must be kept for specific periods of time, depending on the circumstances: • risk assessments must be kept until at least 28 days after the work is completed • entry permits must be kept at least until the work is completed • in the event of a notifiable incident, both must be kept for at least two years after the incident Risk assessments and entry permits must be available to any relevant worker on request for the period that it is kept. Entry permits must also be available for inspection for the period that they are kept	WHS Regulation, s77

Check your skill

CONFINED SPACES CHECK YOUR SKILL

If you are required to be assessed in the skills described in this book, there is a national standard or competency that you can use to check your skills. This is summarised below. This will be useful for assessors, although a full description of the competency and requirements will be needed to assess the skill adequately.

Full details of the competency may be found at the National Register on Vocational Education (VET) in Australia website: *www.training.gov.au*

RIIWHS202D

Enter and work in confined spaces

- plan and prepare for working in a confined space
- access, interpret and apply procedures for confined space entry and the environmental management plan and ensure the work activity is compliant
- obtain, confirm, clarify and apply work instructions and agreed procedure
- obtain, confirm, clarify and apply safety requirements
- obtain and confirm authorisation (entry permit) meets regulatory requirements
- confirm the emergency response procedure is with the standby person and understood
- identify, obtain and implement signage and barrier requirements
- select tools and equipment for the tasks, check for serviceability and rectify or report any faults
- identify, confirm and apply the environmental protection requirements
- position rescue equipment by the entry permit.

Work in confined space

- gain access to confined space
- ensure that the atmosphere is tested and monitored for harmful elements
- correctly apply tagging and lockout procedures
- enter the confined space correctly
- maintain ongoing communication with the standby person
- comply with entry permit requirements
- monitor and adhere to allocated entry time.

Exit confined spaces

- exit confined space correctly
- recover tools, equipment and materials
- conduct inspection of the confined space
- secure access to the confined space
- remove tagging and lockout
- accurately complete confined space entry permit.

Clean up

- clear work area and dispose of or recycle materials
- clean, check, maintain and store tools and equipment
- remove, clean and store barriers and signs.

About the Agskills series

This book is one of a series produced by the New South Wales Department of Primary Industries to provide simple explanations of a wide range of practical tasks performed in farming.

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