+IMPAC | The Health + Safety Company

CONFINED SPACE AND GAS DETECTION

UNIT STANDARD 3058, 17599, 18426, 19207, 25510

+IMPAC

The Health + Safety Company

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We're IMPAC – the Health + Safety Company, proudly New Zealand owned and operated since 1999.

As NZ's leading full-service H+S solutions provider, we have unrivalled experience and expertise at getting the best possible H+S outcomes for our clients. We work alongside them to become true partners, to fully diagnose their needs and deliver solutions to keep their teams safe.

We partner

We diagnose

We deliver

We're here to help.

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COURSE CONTENTS

TIPS

This handout is designed to go with an IMPAC training experience. You will need to refer to it during the training. It is yours to take away and also makes a great reference guide back in the workplace.

Please feel free to add your own notes to this handout.

As you go through this handout with your trainer use a highlighter or underline important words as you are reading. This will make it easier to find key information later.

Use a different colour to highlight or underline words you do not understand or are unsure about, this will make it easier to find them later so that you can ask someone, or look them up.

IMPAC POLICIES

The following IMPAC's policies and process are available in IMPAC's Learner Handbook

- Complaints process
- NZQA Assessment process
- Appeals process.

The IMPAC Learner Handbook is available to download on IMPAC's website, Learning Management System and can be emailed on request.

THE IMPAC CONFINED SPACE AND GAS DETECTION COURSE

This course equips participants, whether entering or observing, with the expertise to recognise various confined spaces and the potential hazards and risks linked to confined-space work. Additionally, it addresses atmospheric testing, necessary equipment for a secure entry plan, and proper emergency procedures for potential rescues.

It also provides the training required towards the achievement of:

- **NZQA Unit Standard 17599 —** Plan a confined space entry.
- **NZQA Unit Standard 18426 —** Demonstrate knowledge of hazards associated with confined spaces.
- **NZQA Unit Standard 25510 —** Operate an atmospheric testing device to determine a suitable atmosphere exists to work safely.

As an NZQA candidate, you are expected to:

- Participate fully in the training session, discussions and activities
- Share your knowledge and experience
- Complete all assessment activities as notified by your trainer
- Take responsibility for your own learning needs
- Discuss with your trainer any assistance you may need.

If you are being disruptive, your trainer will advise you that your behaviour is disrupting learning for other trainees.

If the behaviour continues to disrupt or disturb others, your trainer will ask you to leave the course, and your employer will be notified immediately.

ABBREVIATIONS

- **GRWM Regs:** Health and Safety at Work (General Risk and Workplace Management) Regulations 2016
- **PCBU:** Persons Conducting a Business or Undertaking
- **The Act:** Health and Safety at Work Act 2015 (or HSWA)
- **WEPR Regs**: Health and Safety at Work (Worker Engagement, Participation, and Representation) Regulations 2016
- **WorkSafe:** WorkSafe New Zealand.

ACKNOWLEDGEMENTS

IMPAC recognises the sources of information incorporated into this training manual, reproduced with accuracy to enhance awareness of the risks associated with working in confined spaces.

- Health and Safety at Work Act 2015
- Health and Safety at Work (General Risk and Workplace Management) Regulations 2016
- Australian Standard AS 2865-2009 Confined Spaces.

NOTE: Please be aware that this study guide serves as a supplementary resource to complement the information, instruction, and training offered during your confined spaces course. It is not meant to be a comprehensive list of recommendations. Users are advised to refer to their specific procedural processes, documentation, and relevant legislative and industry guidelines when working in confined spaces.

COURSE LEARNING OUTCOMES:

On completion of the course, candidates should be able to:

- Explain the obligations and responsibilities of all persons involved in confined spaces as stated in the Health and Safety at Work Act 2015 (the Act).
- Describe the obligations and responsibilities of all persons involved in confined spaces as stated in the Standard AS 2865-2009 Confined Spaces.
- Identify a confined space and the risks and hazards that:
  - (a) Are associated with working in or on confined spaces.
  - (b) Arise as a result of work conducted in, or on, or nearby a confined space.
  - (c) Occur from external changes outside confined spaces.
- Assess the level of harm from risks and hazards and determine the suitable control measures needed for confined space work.
- Explain the need for correctly isolating sources of harm.
- Identify gases (and vapours), their causes and harmful effects.
- Correctly select and explain the purpose and operation of gas detectors, including the safety checks and certificates required.
- Perform gas tests to confirm atmospheric conditions are safe, determine action required for unsafe atmospheres and record and interpret measurement results.
- Explain hot work relative to environmental conditions.
- Design and develop a personal emergency procedure and rescue plan, considering: evacuation strategies, actions and essential elements.
- Explain the role of the stand-by person.
- Describe communication requirements.
- Outline the responsibilities and duties of select key personnel for specific functions.
- List personal protective equipment (PPE) that is required for a confined space entry.
- Determine the legal documentation requirements for the entry.
- Complete an entry permit form, and all additional relevant documentation.

INTRODUCTION

INTRODUCTION

Training for entry into confined spaces is crucial because it enables individuals to understand and mitigate the inherent dangers associated with such environments. This includes recognising potential hazards and risks specific to confined spaces, such as poor air quality, limited visibility, and the potential for engulfment or entrapment. By undergoing proper training, individuals can learn to assess and address these dangers, ensuring their safety and that of their colleagues when working in confined spaces.

EXAMPLES OF CONFINED SPACE INCIDENTS:

Two men hospitalised after inhaling hydrogen sulphide. One man was cleaning inside the tank that previously stored a substance for cultivating mushrooms. When he lost consciousness, the second man climbed in to rescue him; he lost consciousness too.

Three men died from lack of oxygen inside a sewer.

A man drowned in slurry after being suffocated by fumes from fermenting wine.

A man steam cleaning the inside of a fuel tank died from lack of oxygen.

Man was killed when engulfed in a silo containing sand.

CONFINED SPACES

MODULE 1: CONFINED SPACES

INTRODUCTION:

From 2011 to 2018, 1,030 workers died from occupational injuries involving a confined space. More than 60% of confined space fatalities occur among rescuers. Therefore, a well-designed and properly executed rescue plan is a must. *(Centre of Disease Control and Prevention).*

LACK OF OXYGEN IS THE MOST COMMON CAUSE OF DEATH

How can fatalities be prevented in the workplace?

- Training and supervision
- Planning, risk assessment and monitoring
- The right equipment
- Effective work and rescue procedures
- Better assertiveness and control
- Eliminating complacency – NO MORE "She'll be right, mate!"

MOST PEOPLE DIE TRYING TO HELP OTHERS

DEFINITION OF A CONFINED SPACE

The Standard defines a confined space as:

- An **enclosed or partially enclosed space** that is **not intended or designed primarily for human occupancy**, within which there is a risk of one of more of the following:

  (a) An oxygen concentration **outside the safe oxygen range.**

  (b) A concentration of airborne contaminant that may cause **impairment, loss of consciousness or asphyxiation.**

  (c) A concentration of flammable airborne contaminant that may cause **injury from fire or explosion.**

  (d) Engulfment in a stored free-flowing solid or a rising level of liquid that may cause **suffocation or drowning.**

- When assessing whether or not your workplace is a confined space, always check it against the confined space definition above.

variable oxygen level

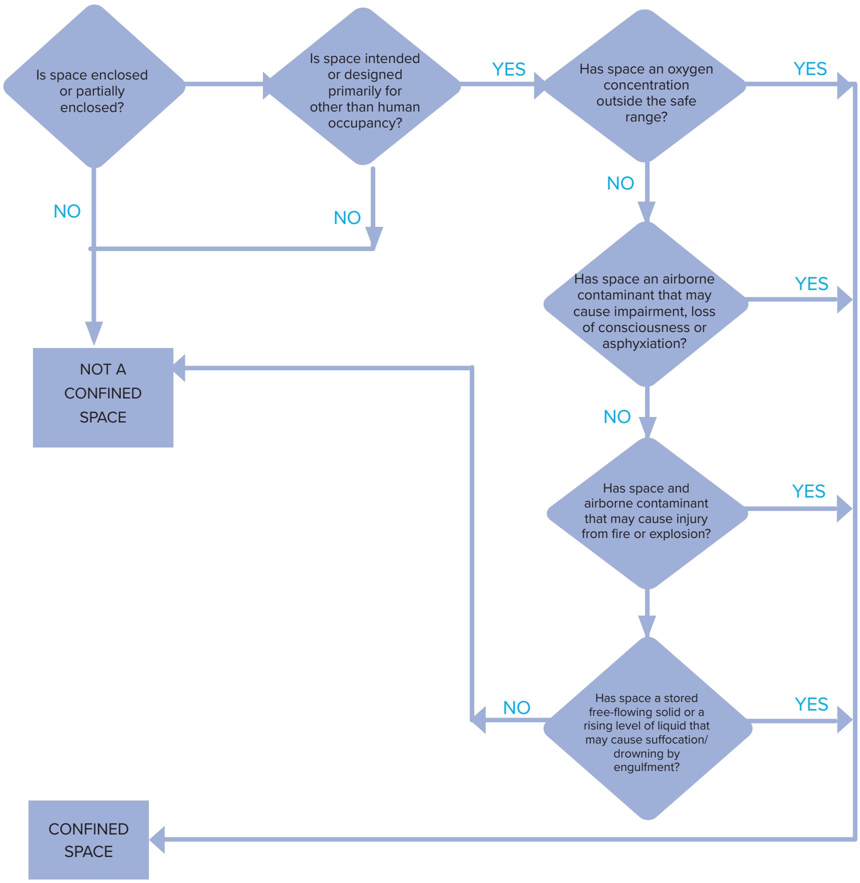
flammable atmosphere

toxic atmosphere

free-flowing solids or liquid

- Confined spaces can be **below or above ground.**
- Despite the name, they can be **very small or very large**.
- They can have **one entry point, or many.**

CONFINED SPACE FLOW CHART



CONFINED SPACE LEGISLATION

EXAMPLES OF CONFINED SPACE LEGISLATION AND STANDARDS

THE HEALTH AND SAFETY AT WORK ACT 2015

The Health and Safety at Work Act (HSWA Act) 2015 is the key work health and safety law in New Zealand and covers nearly all work and workplaces.

PURPOSE OF THE HSW ACT s3

While it does not specifically refer to Confined Space & Gas Detection safety, the main purpose of the Act is to provide for a balanced framework to secure the health and safety of workers and workplaces by:

1. Protecting workers and other persons against harm
2. Providing for fair and effective workplace representation, consultation, and co-operation
3. Encouraging unions and organisations to take a constructive role in making work safer and healthier
4. Promoting the provision of advice, information, education, and training
5. Securing compliance with this Act through effective and appropriate compliance and enforcement measures
6. Ensuring appropriate scrutiny and review of actions taken by persons performing functions or exercising powers under this Act
7. Providing a framework for continuous improvement and progressively higher standards of work health and safety.

DUTY HOLDERS UNDER THE HSW ACT

The HSW Act assigns duties to duty holders:

PERSONS CONDUCTING A BUSINESS OR UNDERTAKING (PCBU)

P PERSON
A legal entity.

C CONDUCTING
Best placed to influence the control of hazards and risks.

B BUSINESS
An enterprise or organisation that does things to make a profit.

U UNDERTAKING
An enterprise or organisation that does things but not primarily to make a profit.

OFFICERS

People with significant influence over the management of the PCBU).

WORKER

A person who carries out work in any capacity for a PCBU.

OTHER

'Other people/person at the workplace' is someone at the workplace who is not a worker or PCBU.

HEALTH AND SAFETY IN EMPLOYMENT REGULATIONS 1995

Regulation 2 and 26 of the Health and Safety in Employment Regulations 1995 states:

REGULATION 2 - **NOTIFIABLE WORK**	• Work where a person may fall 5m or more. • Work of any kind using breathing apparatus. • Working in any pit, shaft, trench or other excavation > 1.5m deep and the depth is greater than the width at the top. • Erecting or dismantling Scaffolding over 5m.
REGULATION 2 - **NOTIFIABLE WORK**	• Notify Worksafe NZ at least 24 hours in advanced.

The HSE Regs require a PCBU to provide at least 24 hours' notice to WorkSafe of particular hazardous work.

Examples relating to confined space work that may require notification include:

- Work in which risk arises that any person may fall five metres or more (with certain exclusions).
- Erection or dismantling of scaffolding from which any person may fall five metres or more.
- Work in which any person breathes air that is or has been compressed or a respiratory medium other than air (such as the use of breathing apparatus).
- Work in any pit, shaft, trench or other excavation in which any person is required to work in a space more than 1.5 metres deep and having a depth greater than the horizontal width at the top.

THE STANDARD

Standard (AS 2865-2009) is recognised by WorkSafe as the document for detailing good practice, design and procedures in New Zealand.

- Australian Standard **AS 2865-2009** Confined Spaces.
- This 2009 Standard replaced AS/NZS 2865-2001 Safe Working in a Confined Space.
- AS 2865-2009 outlines the minimum requirements for establishing a safe system for **entry and working in, on or nearby a confined space.**
- The Standard outlines responsibilities for safety and sets out steps that need to be taken to eliminate or minimise risks that may arise during work operations.

MINIMUM REQUIREMENTS

- Design, entry and exit and service isolation.
- Hazard identification and risk assessment.
- Standby personnel and communication.
- Permits and emergency planning.
- Atmospheric testing, equipment and PPE.

Types of Confined Spaces

Tank-like Compartments:

- Tankers
- Process Vessels
- Boilers
- Silos
- Storage Tanks
- Septic Tanks

Open-top Spaces:

- Pipes
- Pits
- Degreasers
- Sewers
- Shafts
- Man holes

Access Pits or Small Hatchways

- Cargo tanks
- Cellular double-bottom tanks
- Degreasers
- Sewers
- Shafts
- Man holes

When you plan a confined space entry,
Don't just plan to get in -
PLAN TO GET OUT!

Why are there accidents in confined spaces?

Lack of knowledge	Lack of training	Lack of procedures
Complacency and over-confidence	Lack of assertiveness	Incorrect equipment and PPE

Underlying causes for incidents and fatalities

Studies have identified that working in Confined Spaces can be 100x more dangerous than other workplaces.

What is the main cause of death in Confined Space accidents?

Asphyxiation - Oxygen Deficiency.

What are workers most commonly doing when they die?

Rescue - more rescuers are killed than victims.

ATMOSPHERIC EVALUATION

Purpose of Gas Detection and Atmospheric Monitoring

We must ensure that the atmosphere within the confined space is **safe to enter** and that it **remains safe** to allow the job to be completed.

- **Oxygen level:** A presence of oxygen within the safe oxygen range
- **Toxic gases:** That poisonous gas levels do not exceed either short or long-term safe exposure standards
- **Flammable gases/explosive limits:** That the level of flammable gas does not exceed the explosive limits
- **Inert gases:** That inert gases do not present a risk of suffocation
- **Temperature/humidity:** Can lead to dehydration, heat stress and hypothermia.

CLEAN AIR: SAFE OXYGEN LEVEL IS 20.9% BY VOLUME

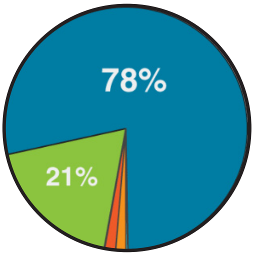
Clean /Breathed Air:

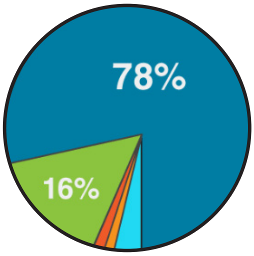
Inhaled clean air contains:

Nitrogen	78.1%
Oxygen	20.9%
Argon	0.9%
Carbon Dioxide	0.03%
Trace gases	0.002%

Exhaled air contains:

- Carbon Dioxide increases
- Oxygen decreases
- Water Vapour is lost from the body





Atmospheric Hazards

Oxygen Deficiency - Ensure safe level of oxygen to breathe i.e. reduce the risk of asphyxiation/suffocation.

Oxygen Enrichment - Reduce the risk of fire/explosion.

Toxic Gases - Prevent short and/or long term exposure.

Flammable Gases - No risk of fire/explosion.

Inert Gases - Displace oxygen increasing the risk of asphyxiation/suffocation.

Volatile Organic Compounds (VOCs) - Flammable and potentially highly toxic at low levels.

Temperature/Humidity - Leads to dehydration, heat stress or hypothermia.

Vapour Density

Vapour density describes the ratio of the weigh of a gas to the weight of air (air has a relative density of 1.0). Gas must be measured in comparison to air at the **same volume, pressure and temperature.**

This allows us to see if a gas or vapour is heavier or lighter than air.

The four key tests undertaken before entry are:

Oxygen

Pre-entry gas tests usually aim for clean air (20.9% oxygen) to allow entry into a confined space.

When working in the space, oxygen is monitored through a safe range which allows some tolerance above and below 20.9%.

AS 2865-2009 advises low alarm (19.5%) and high alarm (23.5%) points are set to avoid exposure beyond safe limits.

The safe working range for oxygen (0_2) is between 19.5% and 23.5%

O_2 Concentration Effects

23.5%	› Explosive and flammable gases more volatile
22%	› Risk of ignition significantly increased
20.9%	› Normal
19.5%	› Minimum for safe work
15-19%	› Impaired coordination
12-14%	› Impaired judgement
8-12%	› Fainting, nausea, vomiting
<8%	› Coma and death

19.5% minimum for safe work

Oxygen Deficiency

Oxygen deficiency stands as a primary cause of fatalities in confined spaces, with critical implications starting at 18% atmospheric concentration. As oxygen levels decrease, the risk of collapse and fatality intensifies.

Recognizable symptoms:

- Nausea, dizziness, heightened breathing and heart rates.
- Reduced capacity for strenuous work.
- Impaired judgment, coordination issues, abnormal fatigue.
- Ultimately, loss of consciousness, respiratory failure, cardiac arrest, and death.

The depletion of oxygen in confined spaces can result from various factors:

Absorption: Inhalation of air that has been absorbed by materials such as grains or chemicals.

Displacement: Introduction of other gases like carbon dioxide, nitrogen, methane, argon, or carbon monoxide into the confined space, which can replace oxygen and pose a serious threat.

Oxidation: Processes like corrosion and rust, or events like explosions and fires, consume oxygen and contribute to decreased levels.

Enriched Oxygen Levels

Elevated oxygen concentrations exceeding 23.5% heighten the likelihood of explosions or fires. This escalation expands the flammable range of combustible materials, causing them to combust more intensely. Excessive levels of oxygen enrichment may even result in spontaneous combustion.

23.5% High risk of explosion/fire

Typical culprits include:

- Oxygen cylinders with leaks
- Oxygen-carrying pipe work featuring damaged valves and fittings.
- Medical oxygen therapy/resuscitation equipment.

Labels classified as Class 5 HSNO are capable of generating oxygen through chemical reactions. It is imperative to store such materials **separately** from flammable substances and other chemicals.

Notes

Flammable Gases and Vapours

Flammable gasses and vapours cannot accurately be detected by human senses. We must use a has detector to provide an accurate reading. It is the ability of a substance to ignite, causing fire or explosion. Flammable substances may form as a gas, vapour, liquid or solid. We measure the gas' "Lower Explosive Limit" (LEL) as a percentage volume.

Examples of Flammables Gases:

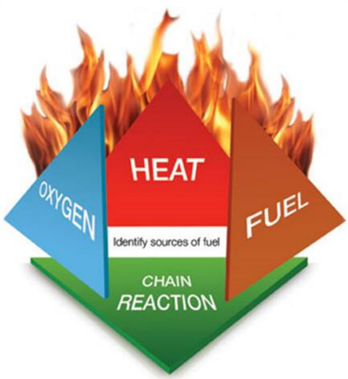
- Vapour producing liquids – Ethanol, Gasoline, Turpentine, LPG, Gas oil, Tallow.
- Gases (stored) – Hydrogen, Acetylene, Xylene, Toluene, Ammonia, Silane.
- Gases (by-products) – Carbon monoxide, Hydrogen Sulphide, Methane.

Flammable Gases - Fire Triangle

Four things must be present at the same time in order to produce a fire:

- Enough oxygen to sustain combustion.
- Enough heat to raise the material to its ignition temperature.
- Some sort of fuel or combustible material.
- Chemical reaction that is fire.

The combination of these three elements in the right mixture is needed to produce a fire or explosion.



Temperature and Flammability

The temperature plays a crucial role in determining the amount of vapour produced by a liquid or solid substance. Additionally, it influences the volatility of a gas, dictating whether it will briefly flash or sustain combustion.

Section 9 of the Safety Data Sheet (SDS) provides essential temperature information for flammable substances:

- **Flash point:** This is the lowest temperature at which the substance can form an ignitable mixture in the air. At this temperature, the vapour will briefly ignite but cease burning once the ignition source is removed.
- **Fire point:** A higher temperature at which the vapour continues to burn after ignition.
- **Auto-ignition temperature:** This is the substance's lowest temperature at which it will spontaneously ignite in a normal atmosphere without an external ignition source.

Flammable Range

The **flammable range** pertains to the spectrum of a gas or vapour mixed with air that can ignite if introduced to an ignition source.

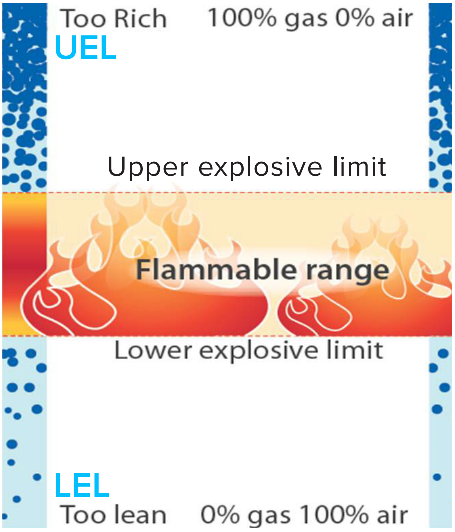
This range encompasses both a **lower and upper limit** concerning the mixture of gas and air.

Various flammable gases and vapours exhibit distinct flammable ranges, with some having wide ranges and others having narrower ones.

Whenever a gas or vapour falls within the flammable range, there is a potential risk of fire or explosion.

Flammable Limits

▷ Maximum concentration of a combustible gas/vapour in air that will flash/ignite if an ignition source is present.



▷ Lowest concentration of a combustible gas/vapour in air that will flash/ignite if an ignition source is present.

Lower Explosive Limit (LEL): The least dense fuel/air combination that can ignite.

▷ This represents the minimum concentration (percentage volume) of a gas or vapour in the air that can generate a flash of fire when exposed to an ignition source (such as an arc, flame, or heat). It marks the lower boundary of the flammable range. Concentrations **below the LEL** are too sparse to burn.

Upper Explosive Limit (UEL): The most concentrated fuel/air mixture that can ignite.

▷ This signifies the maximum concentration (percentage volume) of a gas or vapour in the air that can produce a flash of fire in the presence of an ignition source (like an arc, flame, or heat). It represents the upper boundary of the flammable range. Concentrations **above the UEL** are too concentrated to burn.

Flammable Gases

Flammable vapours can be released from substances like **petrol** and **ethanol** (flammable liquids) or **magnesium** and **sulphur** (flammable solids).

Additionally, hazardous situations can arise from pure flammable gases like **hydrogen** (H2) and compound gases such as **methane** (CH4), **carbon monoxide** (CO), and **acetylene** (C2H2).

The concentration of flammable gases is typically measured in percentage of volume (%).

Your gas detector's flammable (or LEL) sensor can respond to various types of flammable gases. **It's crucial to calibrate the sensor to the specific 'target' gas.**

Methane: (CH_4)

- Methane constitutes the **primary component of natural gas.**
- Naturally, methane can be generated through the **biological fermentation** of organic materials, including **manure, wastewater sludge, and municipal solid waste in landfills.**
- This colourless and odourless gas is lighter than air, possessing a **vapour density of 0.6**.

- Methane stands as the most frequently encountered explosive gas in areas Related to **waste treatment, sewer systems, and trade waste.** It is also commonly present in construction and groundwork settings.

- Functioning as a straightforward asphyxiant, methane can **displace oxygen in confined spaces**, leading to symptoms like drowsiness,nausea, loss of consciousness, and even fatality.
- Accumulation of methane may occur in upper spaces like **mines, tunnels, and chambers,** as well as under manholes and hatch covers.

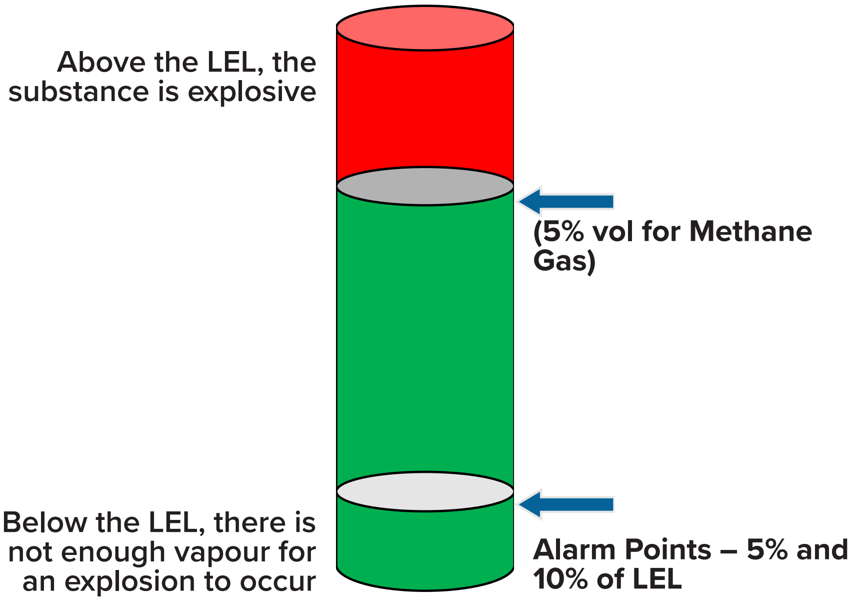
Caution is advised when lifting covers during the pre-entry check phase.

Methane: (CH_4)

Early warning of developing flammable conditions can be given by **setting an alarm below the LEL itself.**

Commonly, alarm points of 5% and 10% of the LEL are set to prevent exposure to the flammable range (to comply with AS 2865-2009).

LEL Alarm



If the LEL is 5% vol, then the LEL Alarm will activate at 0.5% vol i.e. 10% of LEL. Other gases have different LEL values, so their actual alarm points will also be different.

Safety Zones

Plant or site areas are categorised into zones based on their risk level, with three hazard zones identified:

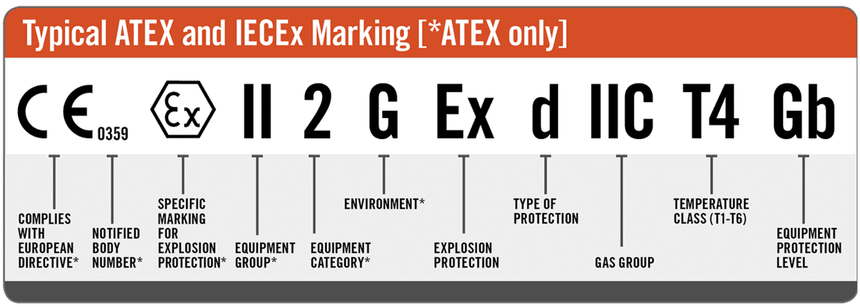
- **Zone 0:** Presence of an explosive gas/mixture is continuous.
- **Zone 1:** Occurrence of an explosive gas/mixture is likely in normal circumstances.
- **Zone 2:** Unlikelihood of an explosive gas/mixture occurrence.

These zones establish safety ratings for electrical equipment like gas monitors, torches, radios, and cameras intended for use in the specified area.

Intrinsic Safety

Intrinsic Safety (I.S.) is a specification for electrical equipment that operates on low energy, designed to avert the ignition of flammable atmospheres. The energy is deliberately restricted to mitigate the risk of sparks or heat leading to an explosion, whether during regular use or in the event of equipment failure.

Intrinsic Safety Standards



- Expert training is needed to understand these systems.
- Each standard uses different codes and measurements and it is vital that the right equipment and systems are put into use in the workplace.

Toxic Gases and Vapours

Inhalation of toxic gases and vapours can result in:

- **ACUTE HARM** - Toxins can be instantly dangerous
- **CHRONIC HARM** - Toxics at lower concentration levels breathed in over a period of time are also dangerous.

Workplace Exposure Standards

- The Workplace Exposure Standards (WES), published by Worksafe NZ, provides information on approximately 700 airborne contaminants and advise on the permissible airborne concentration of a specific toxin that should not be surpassed.
- **These standards serve as a reference for safe exposure levels within the workplace.**
- The measurement of toxic gases and vapours is expressed either in **parts per million (ppm) by volume** or by mass in **milligrams per cubic meter of air (mg/m^3).**
- It is crucial as it sets safe limits for exposure so that workers are protected from ill-health

! Important to make sure you are on the **current version.**

Workplace Exposure Standards

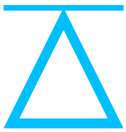
+ **WES**	Workplace Exposure Standard
+ **WES/TWA**	Time Weighted Average
+ **WES/STEL**	Short Term Exposure Limit
+ **WES/Ceiling**	Ceiling
+ **BEI**	Biological Exposure Index
+ **Mg/m^3**	milligrams/cubic meter, used for reporting concentration of solids
+ **PPM**	parts per million

The WES shows three exposure levels that are related to working in confined spaces:

- ▷ WES Ceiling
- ▷ WES STEL
- ▷ WES TWA.

WES Ceiling (Safe upper limit for instant exposure during work)

WES Ceiling is the peak concentration level that should not be surpassed to ensure the safety of workers in terms of exposure to a particular hazardous substance. It serves as a protective measure to prevent adverse health effects associated with prolonged or high exposures to certain substances in the workplace.



WES STEL (Safe upper limit for instant exposure during work)

The Short Term Exposure Limit (STEL) is defined as the concentration to which workers can be exposed for a short duration without experiencing adverse health effects. The STEL is typically expressed in terms of a **15-minute time period, and it sets a threshold that should not be exceeded during that short time-frame.**

WES STEL (Safe upper limit for instant exposure during work)

STEL exposure standards are concerned with the in the body over short periods of time.

STELs help to minimise the risk of:

- Irritation
- Chronic or irreversible tissue change
- Narcosis (sleepiness and unconsciousness), which could increase risk.

This applies to any 15-minute period during the day, it is **not** an alternative to the TWA limit shown below.

WES TWA (Time-weighted average)

A time-weighted average of exposure to an airborne contaminant that should not be exceeded in an **eight-hour working day and a five-day working week (40 hours).**

TWA exposure standards are concerned with the accumulation of toxins in the body over long periods of time.

The TWA may also be known as the long-term exposure limit (LTEL).

Gas Detector Alarm Setting Examples:

GAS	LOW	HIGH	TWA	STEL
O2	19.5% vol	23.5% vol	N/A	N/A
CO	35 ppm[a, b]	70 ppm[b]	35 ppm[a]	200 ppm
CH4	1.0% vol	1.5% vol	N/A	N/A
H2S	10 ppm	20 ppm	10 ppm	15 ppm

Common Gases

Hydrogen Sulphide (H_2S)

- Hydrogen Sulphide is a colourless gas with the characteristic foul odour of rotten eggs.
- It often results from the bacterial breakdown of organic matter in the absence of oxygen, such as in swamps and sewers.
- It also occurs in volcanic gases, natural gas, and some well waters.
- It irritates the respiratory system and kills by paralysing the nerves that control our breathing.

Exposure Information:

- Ceiling: N/A
- STEL: 10ppm
- TWA: 5ppm
- IDLH: 100ppm
- Vapour density: 1.2
- LEL: 4%
- UEL 44%

NOTE: *Toxicity will kill long before the LEL is reached.*

Rotorua, New Zealand.

Carbon Monoxide (CO)

- Colourless, odourless, tasteless, and non-irritating. It is very difficult for people to detect.
- CO is a product of incomplete combustion.
- It is only slightly lighter than air and it can be found at any level in a confined space.
- CO prevents the red blood cells from absorbing oxygen. It often kills by accumulating in the body over long periods of time.

Exposure Information:

- Ceiling: 200ppm
- STEL: 200ppm/15 mins, 100ppm/30 mins, 50ppm/60 mins
- TWA: 20ppm
- IDLH: 1200ppm
- LEL: 12.5%
- UEL: 74% (contributes to 'backdraft' explosions)
- Vapour Density: 0.97

Carbon Dioxide (CO_2)

- ▷ Colourless, odourless, tasteless, and non-irritating. It is **non-flammable.**

Potent asphyxiant:

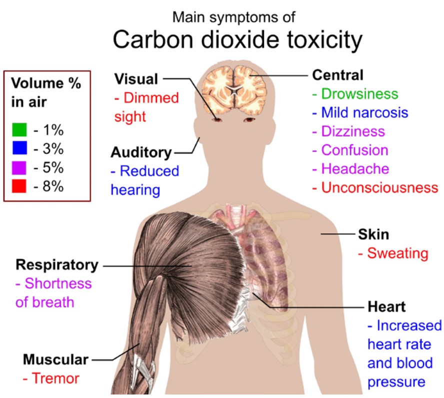
Carbon dioxide (CO2), a by-product of cellular activity in our body, can become a toxin, lowering the pH in body fluids and causing acidosis. It's crucial to expel CO2 through exhaled air for good health. Additionally, like any gas, CO2 can displace clean air, reducing available oxygen levels.

Adverse Health Affects:

- ▷ Hyperventilation (increased breathing).
- ▷ Irregular heartbeats, perspiration, dizziness, and nausea.
- ▷ Unconsciousness, asphyxiation, and potential fatality.

Exposure Information:

- Ceiling: None recommended (first alarm often set at 10,000ppm)
- Background level In clean air: 400ppm; in average office: 1,000ppm to 2,000ppm
- STEL: 30,000ppm
- TWA: 5,000ppm
- IDLH: 40,000ppm (RPE recommended at this level)
- Vapour density: 1.53 (sits low on the ground).



GAS DETECTORS

Gas Detector Technology:

1. Catalytic technology *(also known as Pellistor Bead) used to detect flammable gases:*

- The sensor contains a platinum wire or bead **heated to around 400°C**
- When the flammable gas comes into contact with the wire, it burns hotter and is displayed as a reading on the monitor.

Disadvantages:

- Vulnerable to permanent poisoning by silicones, lead, sulphurs or chlorinated compounds. Need regular calibration to stay accurate;
- Do not fail-safe! Poisoned beads remain electrically operational and will continue to display zero gas even when flammable gas is present;
- Need a minimum of 12% volume oxygen present to operate – efficiency is reduced in oxygen-deficient atmospheres.

2. Electro-chemical Sensors *(Oxygen, Carbon Monoxide & Hydrogen Sulphide can be detected by an electro-chemical cell)*

- Gas combines with the gel in the sensor, initiating a chemical reaction that modifies the electronic current, subsequently reflecting the output reading on the monitor screen.
- The gel or electrodes in the sensor are tailored to the specific gas being detected. A risk assessment of the task, process, and area helps identify the gases requiring detection.

Disadvantages:

- Filters may be necessary to eliminate cross-sensitivity with other gases.
- Susceptible to instability at high and low temperatures.
- Readings are impacted by both high and low oxygen levels.
- Requires frequent high maintenance.

Gas Detector Technology:

3. Gas Detection Tubes *(glass tube filled with colorimetric chemical dye).*

Gas is suctioned in using a hand pump, initiating a chemical reaction that results in a noticeable colour change.

Benefits include:

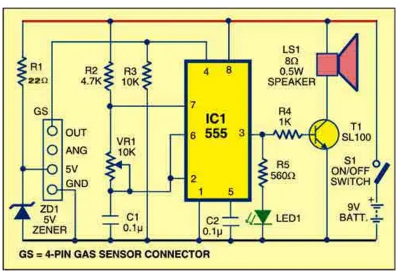
- Checking for leaks.
- Basic assessment of hazardous material pills.
- Quick evaluation of bothersome odours.

However, tubes provide only a momentary sample of the air and cannot replace real-time monitoring. It is essential to utilize additional personal continuous gas detection to ensure worker protection.

4. Chip Management Systems

Chip Management Systems are electronic analysers employing substance-specific measuring chips to generate data, which is then presented as a dynamic readout on the screen.

- Confined space workers can access short-term **real-time** data in the field.
- Competent personnel can download long-term history for archival. storage or analysis, and settings adjustments can be made using a computer link and software.



Testing for Gas

What to consider when testing for gas:

- Weight of gas - relative density.
- Type of gas detector and what type of gas.
- What to do for suspicion of toxic gases:
    1. Identify the type of gas.
    2. Select correct equipment and sensor.
    3. Know relative density.

Pre-Use Checks:

- Verify the **calibration** sticker date, if provided. Is the detector in date? Check calibration due date (every 6 months) on-screen and any stickers used.
- Power on the gas detector in a clean air environment.
- Perform a **function check** to ensure no physical damage, no continuous alarms, successful auto-zero (FAS), bump test.
- Check that the correct gases are indicated on-screen.
- Confirm that alarms, lights, and vibration activate upon start-up but do not persist.
- Verify on-screen calibration date and ensure no continuous alarm is displayed.
- If a continuous alarm is triggered, **inspect for fault icons or a low battery.**
- Conduct a bump test following company and manufacturer policies.

Testing for Gas

Start-up checks

Zeroing the gas detector

Sets the sensors to zero levels in clean air. Also known as clean air setup (FAS).

With the various types of sensor technology, '**drift in sensor output**' can sometimes occur.

The unit should be zeroed prior to use, and this must be done in a clean/clean air environment.

Bump testing the gas detector

A bump test provides the user with evidence that the detector will alarm if exposed to gas above safe levels. However, not all detectors give details of the exact alarm actuation levels achieved during the test.

NOTE: Gas detection manufacturers recommend this is done before each day's use by a competent user. (Refer to gas monitor instruction manuals).

Gas detector calibration

As a general guide, gas detectors should be calibrated at least every six months. If the detector is used in aggressive conditions, this may need to occur more regularly.

NOTE: Manufacturers' instruction manuals will contain specific guidance. Only competent workers should bump-test equipment.

NOTE: If in doubt, return the detector immediately for professional servicing.

Gas detector battery and charging

Turning off the detector to conserve battery life, or battery failure, **resets the detector's memory**. This means that personal TWA and STEL readings are **no longer accessible** in the field for that entrant.

Using a new monitor, or recharging and restarting this one, does not take into account previous exposure and may be dangerous (TWA or STEL levels could be exceeded without knowledge).

NOTE: Preserve your battery to preserve data for your personal daily exposure.

Pre-entry Gas Testing

Steps before starting:

- **Paperwork:** All relevant documents are handed over and all pre-testing requirements have been completed.
- **Isolations:** You have signed on to an isolation tag.
- **PPE:** Wearing appropriate PPE.
- **Confirm location:** You are testing the correct vessel with the correct type of gas detector.

Pre-entry testing methods include:

- Lowering the detector vertically into the space.
- Using a pole to horizontally extend the detector into a space.
- Employing a hand sample or electric pump with a tube to draw a sample into the detector.
- Consideration of vapour density is **crucial**; **lighter gases tend to accumulate in the upper part of a space, while heavier gases are often nearer to the ground.**
- Air movement within the confined space can lead to the circulation of gases, potentially causing them to be present in unexpected areas. Dead spaces, characterised by no air movement, may conceal gases.

NOTE: **It is vital to take samples at various levels and from as much of the area to be entered as possible from outside the confined space.**

Pre-entry Gas Testing

Pre-entry Gas Testing Technique:

1. Check space is safe **BEFORE ENTRY.** Before opening a manhole, cover or hatch, **clear away as much dirt, debris, tarmac and vegetation** as possible.

   Check the edges and any vents or gaps for signs of gas that may already be present with the access point still closed for at least one minute.

   Test and check peak readings and continue if clear.

2. Consider the possibility of ignition from hammers and tools when opening the cover.

   Partially open the access point and **allow it to vent** for at least one minute, ensuring all personnel stay upwind.

   Check the gap created for gas readings.

   Check peak readings and continue if clear.

3. Open fully and c**heck the levels** of the confined spaces.

4. Record the result.

As a general model, Pre-entry Testing is shown here using 3 test levels with different durations.

Target Gas		Unit	Pre-entry Levels
O_2	Oxygen	% volume	20.9
CO	Carbon Monoxide	ppm	0
H_2S	Hydrogen Sulphide	ppm	0
CH4	LEL of Flammables	% volume	0

Ventilation, Purging and Suction

Ventilation:

Introduction of ventilation may be necessary to "clean up" the atmosphere and enhance the detection of gases in blind tunnels, shafts, or complex spaces during pre-entry gas testing.

Passive Ventilation (Natural): Allowing the natural flow of air by opening available hatches or covers to create a through draft. Natural ventilation's effectiveness is influenced by wind direction and force and may not be consistently reliable in specific situations.

Mechanical Ventilation (Forced Air): Utilizing electrical or engine-driven fans. Negative pressure systems "suck" air, while positive pressure systems "blow" air through the space.

- Introducing clean air through positive pressure can dilute gases, creating a protective pressure within the confined space.
- Avoid sucking or drawing air through the blower if combustible gases are present, as this can move the hazard to the clean-air zone outside the space, endangering the entire team.
- Ventilate as low as possible to affect heavier-than-air gases like H_2S or CO_2.
- Employ flexible ducting to reach "dead" spaces and ensure effective ventilation.
- Positive-pressure fans can push gases into dead spaces, corners, and blind alleys, forming gas pockets; ensure proper airflow to prevent this.
- Non-intrinsically safe blowers may pose an ignition risk for flammable gases.
- Prevent the drawing of exhaust gases into the space through the fan.
- Consider the impact of ventilation operations on pre-entry gas tests.

Ventilation:

How much you ventilate will vary according to the conditions in the confined space and the type of work being undertaken. Points to consider include:

- Time of day (flow, volume and content changes in sewers, drains and tanks)
- Time of year (seasonal changes in conditions affecting biological processes)
- Weather changes (affecting biological processes, heat and humidity; and flow and depth of liquid)
- Discharge and charging of tanks and nearby or connected systems
- Presence, or absence, of natural ventilation and air flow
- Consumption or displacement of clean air by workers or processes.

CONTINUOUS MONITORING IS CRUCIAL TO EFFECTIVE VENTILATION

Suction:

- Suction is used to remove product residues and ingress of water or other unwanted liquids and sludge.
- This process can remove the source of biologically generated gases, or a vapour-producing substance.
- Using a 'vac-truck' can also cause some air to be moved into the space as it sucks out the material (due to the negative pressure created, known as the Venturi principle or Venturi effect).
- In this way it is possible to combine a limited level of ventilation during suction operations. This can move gases out of dead spaces and make them easier to detect from the surface.
- Always consider the need for the surface worker to be protected by gas monitoring during this kind of work, nearby the space.

Purging:

- Purging can be conducted to remove any existing contaminants by displacing the hazardous atmosphere with another medium such as air, water, steam or inert gases (depending on the nature of the contaminants).
- Often followed by ventilation with air to enable entry to the confined space.
- Accurate warning on the permit and effective barriers and signage are a must to avoid exposure.
- WARNING: Purging generally uses inert gases or non-toxic substances.

Continuous Monitoring

The atmosphere within a confined space can change without warning.

Continuous monitoring is required to ensure the atmosphere within the confined space remains safe to allow workers to continue working within the space or nearby.

If your alarm sounds, you MUST leave immediately.

Consider the need for other monitors:

- Standby person(s) to wear their **own** monitor at the entry point.
- Other team members on or near the entry point.
- Hanging 'sentinel' monitors inside the space to monitor ladders and shafts.
- Use of fixed monitors built into the space.

Gas Detector Alarm Actions

In the event of a gas alarm, the emergency evacuation plan must activate without delay.

- Entrant MUST exit the space. **Standby worker should confirm that the entrant is fit and well.**
- Ventilate the space using available equipment.
- Conduct a pre-entry gas test.

Low and High Alarms

- Setting low and high alarms is crucial to prevent exposure beyond the WES ceiling.
- The recorded data will provide insights into the level of exposure.
- Upon successful ventilation and completion of pre-entry checks, individuals can safely re-enter the space if they are in good health.

TWA alarms: Protect against long-term accumulation of toxins in the worker's body tissues.

An alarm indicates the **daily limit has been exceeded.**

For a normal shift of eight hours, the entrant should stay in clean air until the beginning of the next shift in order to fully recover. For longer shifts, specialist calculations will be necessary to determine a suitable recovery time.

NOTE: Workers' reactions may vary so if in doubt, always act on the side of safety.

STEL alarms: Protect against short-term accumulation of toxins in the worker's body tissues.

Recorded data will reveal if this is the source of the alarm.

Workers must stay in clean air for **one hour after the alarm**, before considering re- entry into the space.

This cycle can be repeated **up to four times** in a working day for the same entrant.

Testing for Gas

Limitations of Gas Detector Performance and Recognising Faults:

Oxygen Enrichment	May cause sensor overload and lead to inaccurately low oxygen readings. **Monitor for underlying causes and changes in conditions. Pay attention to patterns such as a high reading followed by a low reading and subsequent erratic fluctuations.**
Low Oxygen	The catalytic sensor may not work in atmospheres containing less than 12% O_2, giving false LEL readings. **Risk assess for root causes and proceed with effective controls to monitor for changes.**
Liquid	Liquid presence can obstruct sensors, preventing gas from reaching them and leading to inaccurate readings. **Position the monitor strategically to prevent contamination or submersion.**
Atmospheric Temperature	High or low temperatures may result in incorrect gas readings in electrochemical sensors. **Check manufacturer's guidance on temperature ranges. Monitor and avoid.**
Sample Temperature	Differences in sample and atmospheric temperatures can lead to measurement errors when spot testing. **Monitor and factor in to testing procedure.**
Sample Pressure	Increased pressure widens the flammable range of a gas by lowering the LEL and raising the UEL. **Risk assess and monitor when working in pressurised areas.**
Contaminants	Physical material can block the sensors, preventing the gas from reaching them. Certain common products can poison sensors and give false readings. Risk assess for root causes. **Read manufacturer's guidance on sensor poisons and contaminants.**
Cross-sensitivity	Some gases pose as other gases, which can mislead both the sensor and the user. May lead to dangerous exposure. **Risk assess for all suspected gases and consider use of sensor filters to block confusing readings.**
Calibration	Incorrect calibration can damage the sensors. **Ensure meter is calibrated correctly by competent personnel, using the correct calibration gas, in a clean environment.**
Bump Testing	Incorrect 'challenge gas' selection leads to false results. Poor technique can overload and damage sensors. **Ensure operators are competent and follow manufacturer's guidance.**
Fit for purpose	Wrong choice of monitor setup will not be able to detect target gases. **Choose correct monitor and calibration according to risk assessment.**

RISK MANAGEMENT

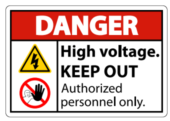
Danger or Risks: The Difference

- When addressing workplace safety hazards it seems necessary to draw a distinction between **“danger”** and **“risk”.**
- “Dangers” are all aspects and framework conditions that could have a **threatening influence on people, the environment, and plant safety** with regard to a specific work situation. Such as entering a confined space.
- “Risks” are understood by workplace safety experts as the evaluation of the **probability that this danger will occur in this exact situation** and describes the specific potential of a hazard.

Hazards in a Confined Space:

Engulfment in a liquid or free-flowing solids.


Impact, entrapment and entanglement.



Electrical, chemical and biological hazards.

Noise.


Temperature and/or exhaustion.


Radiation.

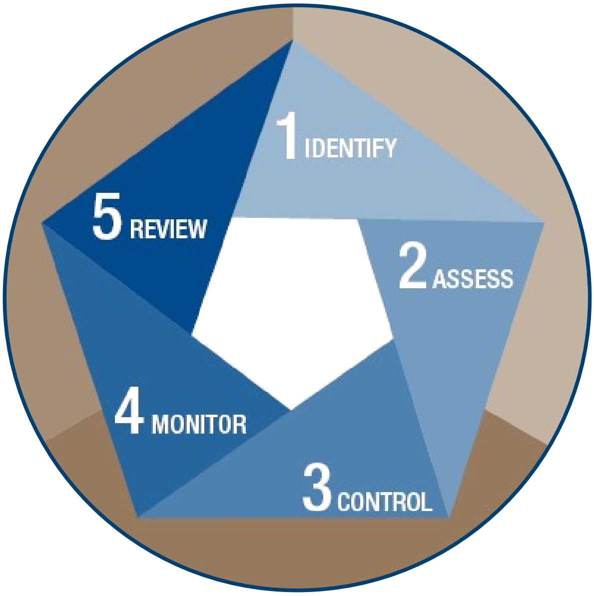
Manual Handling.

Falls, trips and slips.


Psychological stress.


Poor lighting.

Risk Assessment



Stage 1: Identify Hazards:

- **Task Analysis:** Certain tasks require a demonstration of proactive planning. A Task Analysis stands out as a valuable planning tool, ensuring the identification of all risks and corresponding control measures. This should articulate your safe job execution plan, providing evidence of effective risk management.

Decide where the hazards are found:

Work Area Hazard

Process related Hazard

Task Related Hazard

Stage 2: Assess the Risks:

- Once a hazard is identified, it is crucial to assess the associated risk level concerning its potential impact on individuals, the environment, or the organisation.

When conducting a risk assessment, two fundamental questions should be addressed:

- What would be the **consequence** if an individual were to come into contact with the hazard in its current state without any protection?
- What is the **likelihood** of this consequence occurring given the hazard's current state and location?

Risk Assessment Tools:

- Organisations employ various methods to evaluate risk, with a risk assessment matrix being a common tool. This guide assists in determining the risk level posed by the raw, uncontrolled hazard.

Caluclating the level of Risk:

STEP ONE: Determine the potential consequence

- Choose the category for analysis (people, environment, or organisation). For instance, consider toxic gas affecting people or an eco-toxic spill affecing the environment. Note that some hazards may impact multiple categories, requiring precise assessment for each.Evaluate the potential harm and identify the most severe consequence.

STEP TWO: Determine the potential likelihood

- At the top of the matrix, identify the likelihood of harm occurring, assessing the raw, uncontrolled hazard.

STEP THREE: Determine the Risk Score

- By intersecting the Catastrophic row and the Likely column, the Risk Score is obtained.

Risk Assessment Matrix

RISK SCORING

			Severity				
			1 First Aid	2 Minor	3 Serious	4 Severe	5 Fatality
Likelihood	5	Almost Certain	5	10	15	20	25
	4	Likely	4	8	12	16	20
	3	Possible	3	6	9	12	15
	2	Unlikely	2	4	6	8	10
	1	Remote	1	2	3	4	5

JSA SIGN OFF

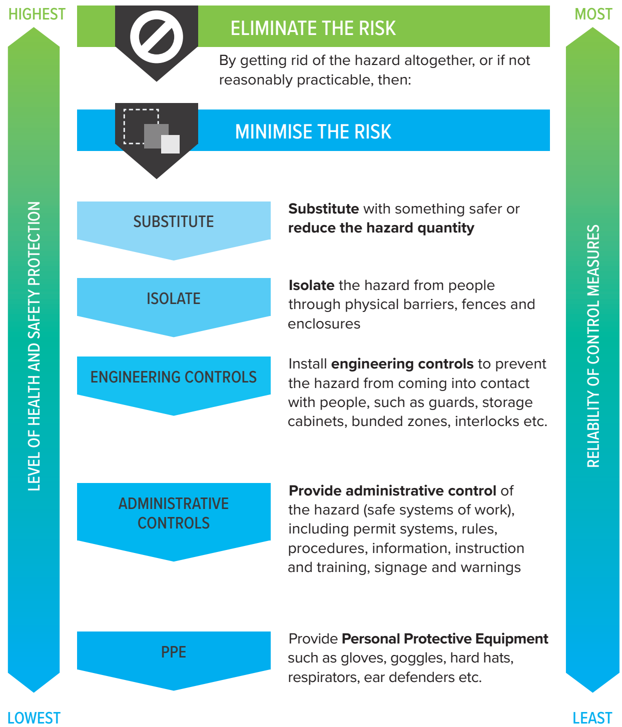
Where residual risk score cannot be reduced to low the escalations listed below must be enacted.

Escalated by (Name):	Signature:

Low	1-4	Proceed with agreed controls in place
Medium	5-6	Escalation to Foreman
High	8-10	Escalation to Area/Department Manager
Extreme	12-25	Escalation to EMT Representative

Stage 3: Identify the controls

- During this step, the measures to be taken to control each hazard are decided using the Hierarchy of Controls.
- The hierarchy of control dictates the sequence in which risks should be addressed. The initial priority is to eradicate the risk whenever feasible. If elimination is not possible, the next course of action involves minimizing the risk.



Eliminating the risks:

- Can we eliminate any of the hazard(s)
- Can we eliminate the need for someone to enter the confined space to get the task done?

For example:

- Remove machinery
- Empty contaminants from the confined space.

Strategies to decrease or mitigate the risk encompass:

- Substitute: Employ a less perilous tool for task completion.
- Isolate:

  Site isolation: Prevent individuals from encountering the hazard through measures like noise shielding or establishing secure working zones/barriers.

  Energy isolation: Utilise lockout, tagout systems (LOTO), de-energise and lock out electrical supply, close valves or gates, and employ welding screens to confine sparks.
- Implement: Integrate engineering controls such as built-in ventilation or gas detection systems..

Administrative Controls:

Examples encompass:

- Standard operating procedures (SOP)
- Safe work practices and emergency plans
- Permit to work (PTW) for activities like confined space entry, hot work, and entry logs
- JSA, JTA, JSEA, SWMS, SSSP
- Safety data sheet (SDS)
- Signs and confined space register (a list of confined spaces onsite).

Warning signs and risk registers fall under the category of administrative controls, serving as crucial sources of information on potential workplace hazards and the corresponding control measures.

Personal Protective Equipment:

- As the final control measure in the hierarchy, **it is imperative not to rely solely on Personal Protective Equipment (PPE).**

Instances of PPE encompass:

- Respiratory protective equipment (RPE)
- Head, eye, and body protection
- Height systems such as fall restraint and fall arrest
- Gas monitors.

After finalizing the plan for implementing controls, the P**CBU must furnish adequate information, training, and/or supervision** to those working with these controls, ensuring a comprehensive understanding of their proper implementation.

Monitor through Communication:

Continuous communication is important because it:

- Allows for regular checks
- Enables immediate emergency response
- Allows for rapid warning of atmospheric changes

Continuous visual monitoring allows observation of:

  - Unusual or unsafe behaviour
  - Uncoordinated movements
  - Bad temper/mood changes

- Atmospheric monitoring and testing
- Test before entry
- On-going monitoring

  (a) Oxygen concentration

  (b) Concentration of flammable gases

  (c) Toxics (WES)

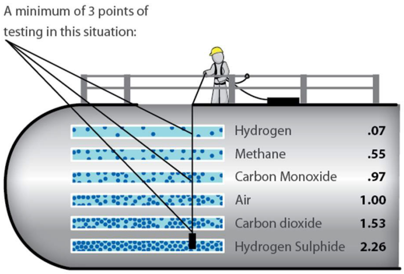
  (d) Temperature levels

Review all activity periodically:

Check that hazards are controlled, and look for ways to improve

Triggers:

- Time period
- Legislation changes
- Organisational changes
- New technology
- Lessons learned and feedback from incidents



Key personnel involved – Roles & Responsibilities

Personnel Selection:

- Engaging in tasks within confined spaces poses risks and can impose additional cognitive, physical, and physiological challenges on involved personnel.

- Conducting medical screenings, reviewing medical histories, and fostering an open team environment enable the ongoing monitoring of conditions that could affect the safety of workers.

Key Personnel Involved:

- Manager/Site Supervisor
- Person entering confined space
- Permit Receiver
- Permit Issuer
- Stand-by person/safety observer

The Manager / Site Superviser

The manager oversees operations and assigns competent people to:

- Identify and risk assess confined spaces.
- Issue and receive of access authorities/permits.
- Stand-by/safety observer and emergency response.
- Atmospheric testing or monitoring.

Permit Issuer:

- Identify hazards with the permit receiver.
- Ensure confined space is correctly isolated.
- Provide drawings or sketch of confined space.
- Ensure all gas tests are done before entry.
- Evaluate if a harness and life line system is required.
- Ensure the stand-by person knows their responsibilities and key actions.
- Make sure all hazards are identified.

Permit Receiver:

- Check all isolations and blinds.
- Carry out task analysis for the work activity.
- Place personal locks as appropriate.
- Ensure trained stand-by person is present.
- Check all safety and monitoring equipment is in place.
- Accept and abide by conditions on permit.
- Stop work and inform the permit issuer if the scope of work changes.

Stand-by Person:

- Those assigned as standby personnel will face additional responsibilities. Beyond regular duties that demand effective personnel management, they are responsible for deploying and operating equipment and procedures to oversee entry control.

- As the central point for team communication, they must maintain continuous and effective contact with the entrants throughout the process. In emergencies, their composed approach is crucial for initiating and executing an assisted non-entry rescue, relying on a mature and well-practiced response.

- **The four main areas of responsibility for the stand-by person are:**

  (a) Communication

  (b) Entry control

  (c) Monitoring and observation

  (d) Emergency response

Entrant:

- Entrants must possess both physical and mental capabilities suitable for entering confined spaces and performing required tasks. This may involve a certain level of mobility and physical fitness, particularly when operating in cramped or hot/humid conditions or while wearing breathing apparatus.

- Successfully executing self-rescue demands a composed mindset and the physical capacity to exit under pressure.

FIRE EXTINGUISHER TRAINING JOB SAFETY ANALYSIS

+IMPAC
Less risk, safe people, better business

JSA DETAILS						
Job Description:	Fire Extinguisher Training Practical Scenario		**Facility:**		**Business Unit:**	
Date:		**Department:** Training	**Location:**			

RISK SCORING						
		Consequences				
		1 First Aid	**2 Minor**	**3 Serious**	**4 Severe**	**5 Fatality**
Rear 5	**Almost Certain**	5	10	15	20	25
4	**Likely**	4	8	12	16	20
3	**Possible**	3	6	9	12	15
2	**Unlikely**	2	4	6	8	10
1	**Remote**	1	2	3	4	5

JSA SIGN OFF
Where residual risk score cannot be reduced to low the escalations listed below must be enacted.

Escalated by (Name):	Signature:

Low	1-4	Proceed with agreed controls in place				
Medium	5-6	Escalation to Site Supervisor	Site Supervisor's Approval:		Date:	
High	8-10	Escalation to Area/Department Manager	Department Manager:		Date:	
Extreme	12-25	Escalation to EMT Representative	EMT Member Consulted:		Date:	

JOB STEP		POTENTIAL RISK	INITIAL RISK			REQUIRED RISK CONTROLS	RESIDUAL RISK		
Step Nº.	**List job steps in the sequence they are carried out.**	**List the potential risks for the job step.**	**Likelihood**	**Consequenc**	**Risk Score**	**List the controls required to eliminate or control the risk.**	**Likelihood**	**Severity**	**Risk Score**
1	Establish workplace	People/Traffic	N A	N A	12	Erect barriers Inform stakeholders	N A	N A	3

FIRE EXTINGUISHER TRAINING JOB SAFETY ANALYSIS

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JOB STEP		POTENTIAL RISK	INITIAL RISK			REQUIRED RISK CONTROLS	RESIDUAL RISK		
Step Nº.	List job steps in the sequence they are carried out.	List the potential risks for the job step.	Likelihood	Consequenc	Risk Score	List the controls required to eliminate or control the risk.	Likelihood	Severity	Risk Score
		Dust	NA	NA	16	Check wind direction to prevent spread of Dry Powder	NA	NA	8
		Weather	NA	NA	12	If weather adverse cancel fire blanket exercise	NA	NA	6
		Fire Spread	NA	NA	16	Avoid setting up near to flammable materials/ substances, buildings or vegetation. Be aware of any fire restrictions in the local area	NA	NA	4
2	Set Up Equipment	Trips/Slips	NA	NA	12	Set up equipment to reduce trips Consider using water FE instead of fixed (garden) hose reel Brief participants (awareness)	NA	NA	6
		Manual Handling	NA	NA	15	Apply correct lifting techniques or separate load out into smaller loads where possible Wear leather gloves	NA	NA	6
		Flammable Gas (LPG/ Butane)	NA	NA	16	Secure connections Use spray bottle with soapy water to check for leaks Wear leather gloves	NA	NA	4
		Flammable Liquid (Petrol)	NA	NA	16	Store away from fire box Avoid spillage. Wear leather gloves	NA	NA	4

IMPAC – Job Safety Analysis Document ID: Last updated: Dec 2023 Page 2 of 5

FIRE EXTINGUISHER TRAINING JOB SAFETY ANALYSIS

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JOB STEP		POTENTIAL RISK	INITIAL RISK			REQUIRED RISK CONTROLS	RESIDUAL RISK		
Step Nº.	List job steps in the sequence they are carried out.	List the potential risks for the job step.	Likelihood	Consequenc	Risk Score	List the controls required to eliminate or control the risk.	Likelihood	Severity	Risk Score
		Hot metals	N A	N A	16	Fill fire box with water to dissipate heat. Wear leather gloves.	N A	N A	4
3	Practical Exercise	Fire/Burns	N A	N A	16	Arms to be covered. Emergency FE identified. Fire blanket available. Wear leather gloves and safety glasses.	N A	N A	4
		Training	N A	N A	9	Competent trainer Students under supervision	N A	N A	3
4	Re-commission Worksite	Environmental	N A	N A	12	Transfer waste water to 'dirty' water container Avoid spillage to drains	N A	N A	3
		Pressurised cylinder – LPG cylinder and Fire Extinguishers	N A	N A	16	Ensure extinguishers stored correctly and tape/tie handles to prevent accidental discharge	N A	N A	4
		Pressurised LPG Hose	N A	N A	16	Turn off LPG cylinder purge gas line into water filled fire box	N A	N A	4

FIRE EXTINGUISHER TRAINING JOB SAFETY ANALYSIS

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Less risk, safe people, better business

JOB STEP		POTENTIAL RISK	INITIAL RISK			REQUIRED RISK CONTROLS	RESIDUAL RISK		
Step Nº.	List job steps in the sequence they are carried out.	List the potential risks for the job step.	Likelihood	Consequenc	Risk Score	List the controls required to eliminate or control the risk.	Likelihood	Severity	Risk Score
	Emergency Plan	1) Safety briefing at start of exercise to include emergency procedures, use of fire blanket and FEs, location of fire alarm call points and any fixed hose reels. 2) Physical address of site. 3) Burns Kit to be available. 4) Contact numbers for Emergency Services and/or ERT. (5) Shut-off LPG line valve. (6) If clothes on fire; Stop, Drop and Roll to smother fire.							

JSA SIGN OFF AND ACCEPTANCE

We confirm that we understand this JSA and recognise that its purpose is to control the risks that are present for this task.

Name	Signature	Date	Name	Signature	Date
Trainer -					
Student -					

FIRE EXTINGUISHER TRAINING JOB SAFETY ANALYSIS

JOB STEP		POTENTIAL RISK	INITIAL RISK			REQUIRED RISK CONTROLS	RESIDUAL RISK		
Step Nº.	List job steps in the sequence they are carried out.	List the potential risks for the job step.	Likelihood	Consequenc	Risk Score	List the controls required to eliminate or control the risk.	Likelihood	Severity	Risk Score

EMERGENCY PROCEDURES AND RESCUE PLANS

The Standard

Standard AS 2865-2009 Confined Spaces

AS 2865-2009 states that: "The employer shall ensure that **appropriate** rescue and first aid procedures and provisions are **planned, established and rehearsed.**"

A comprehensive emergency plan must be in place **before entry,** and it should be **documented on or attached to the entry permit**. The emergency plan must encompass the following aspects:

- **Planned:** Clearly documented and discussed to ensure a coordinated approach.
- **Established:** Well-organized and readily available, with specific duties and actions assigned to all involved parties.
- **Rehearsed:** Practiced to ensure a desirable outcome in the event of an emergency.

UP TO 2/3 OF CONFINED SPACE FATALITIES ARE WOULD-BE RESCUERS

Essential elements of a confined space rescue plan

Identify potential emergency scenarios associated with the entry:

- Outline the specific hazards anticipated during emergencies.
- Define the required rescue procedures for each emergency scenario.
- Set up communication systems involving entrant(s), other involved parties, and external emergency services.
- Develop a plan for providing first aid and CPR.
- Determine the frequency of required rehearsals each year.
- Select appropriate, certified safety, and rescue equipment for the entry.

Emergency Response

In an emergency scenario, the standby person(s) must possess **competence** and **confidence** to evaluate the situation and undertake appropriate actions.

Recommended standby actions during an emergency include:

- Refrain from entering the situation.
- Prioritise personal safety, maintain discipline, and resist the urge to intervene impulsively.
- Secure evident sources of harm (if safe to do so).
- Stay at the entry point.
- Prohibit unauthorised entry.
- Call for assistance, involving team members, onsite Emergency Rescue Team (ERT), or offsite emergency services.
- Retrieve the casualty without entering the confined space.
- Evaluate the casualty and administer first aid and CPR if needed.
- Sustain continuous communication with casualties inside the confined space.
- Secure the scene to prevent additional harm and facilitate post-rescue investigation (internal procedures and WorkSafe investigation as required).

Golden Rule:

In an emergency, **the primary focus is on the survival of the casualty.** However, immediate rescue may not always be imperative or the appropriate course of action. **Avoid hastily rushing in to aid a fallen colleague.**

Evacuation Strategies for Rescue

When creating a rescue plan for confined spaces, careful consideration must be given to the utilisation of the three rescue stages:

- Self-rescue.
- Assisted rescue.
- Rescue by trained rescuers.

Factors like the scope of work, the number of entrants, the layout and size of the work area, as well as the levels of hazard and risk, are examples of elements that may influence the decision on which stages are applicable and advisable.

Self-Rescue

Self rescue refers to a worker exiting the space on their own, without delay, when it is no longer safe to remain in the space.

- Self-rescue occurs when an entrant independently exits the space due to identified hazards, feeling unwell, or in response to a gas monitor alarm signaling potential danger. In locations like gas plants, ongoing monitoring for lower explosive limit (LEL) may be necessary.
- Monitors also detect the presence of hazardous gases inside the space beyond the permissible exposure limit (PEL).

Scenarios might include:

- Alarm activation.
- Incident occurs.
- Feeling unwell / minor injury.
- Co-worker collapse.
- Conditions change.

EXIT CONFINED SPACE IMMEDIATELY

Assisted Rescue - By Stand-by Crew

Immediate response by the standby individual:

An assisted / non-entry rescue involves attempting to extricate an incapacitated person without having anyone else enter the confined space. This can be done via a safety line attached to the personnel in the confined space or by grabbing the personnel with a rope, strap, or pole and pulling them to safety.

Stand-by crew must:

- Always from outside the confined space.
- Rescue using suitable equipment.
- Entrant must remain connected to system at all times.
- Entrant and safety crew must monitor for hazards that could prevent successful retrieval in an emergency.
- Render first aid /CPR as needed.

Scenarios might include:

- Entrant not responding/impaired.
- Entrant collapses.
- Communication breakdown.
- External emergency, where the entrant is unaware of the situation and is unable to exit without assistance.

Rescue by trained Rescuers - ERT

A Stage 3 rescue must always be affected by a trained and competent confined space rescue team – NOT THE STANDBY PERSON.

If self-rescue and assisted rescue are not viable options, the standby individual should promptly request trained rescue support (the team leader may delegate this responsibility to another team member). This involves notifying an on-site trained rescue team and/or seeking support from external emergency services.

Scenarios might include:

- Changes in level and direction.
- Narrowing and slopes.
- Pipes, ducting and other snags.
- Machinery, plant and obstructions.
- Distance from entry point.
- Equipment failure.
- Disconnection from system.

Trained Rescue team might be:

- Onsite emergency response teams: May be an internal company team or a contracted-in team, e.g. company workers may be trained as breathing apparatus standby crew for a single job, or a full emergency rescue team (ERT) may be provided to cover a whole site or a complex job.
- Offsite rescue teams: Will be an externally located resource and may include Emergency Services (Fire Service, St John) or local confined space rescue teams (Search & Rescue [SAR] volunteers or private teams).

REMEMBER THE STAND-BY PERSON IS NOT A MEMBER OF A TRAINED RESCUE TEAM!

Basic Emergency Equipment

An important part of developing an emergency plan is identifying what emergency equipment is needed.

Emergency equipment likely to be required includes:

- Safety harnesses.
- Lighting.
- Breathing apparatus.
- Emergency escape breathing apparatus.
- Fire-fighting equipment.
- First aid trained personnel and equipment.

Communication and Emergency Response Plans

- The stand-by person should provide a direct and continuous communication link to the entrant.
- The stand-by person must be able to quickly raise the alarm on site, which should set in motion general emergency procedures.
- Rescue practices in stimulated or actual spaces should be performed at least once every 12 months.

Re-evaluate the plan whenever:

- Conditions change within the space.
- Workers discover any new hazards.
- There are changes in the rescue personnel.
- New equipment is purchased.
- Routine training results are unsatisfactory.
- A rescue plan is found to be deficient.

Communication Systems

Effective communication is paramount for the safety of every confined space entry. It serves as a vital lifeline connecting:

- The standby person and the entrant(s).
- The standby person and team members.
- The standby person and trained rescuers.

Visual Communication:

The Standard advises that the standby person should strive to maintain clear visual contact whenever feasible.

Sustaining continuous visual contact offers immediate awareness of any emergency situations.

This facilitates a swift initiation of emergency procedures, preventing time delays.

To ensure effective communication, it might be necessary to station additional workers in the space for visual contact, relaying messages from the entrant.

Visual communication may face limitations due to:

- Dim lighting and darkness.
- Malfunction of lighting equipment.
- Work activities generating steam, dust, etc.
- Entrant moving behind obstacles, changing levels, or navigating corners.

Continuous Visual Monitoring:

- The standby person or safety observer ensures uninterrupted visual contact with the entrant at all times, observing the required tasks.
- Some advantages of visual monitoring include instant awareness of issues and a prompt response to emergencies.
- Visual monitoring may have limitations such as poor visibility and an obscured view of the entrant.

Verbal Communication

As visual communication may easily be lost, it is important to have a backup communication channel at all times.

- Confirms the status of the entrant when they are not moving
- Allows a quality check on their level of consciousness (vital when assessing low-oxygen symptoms)
- Provides continuous verbal feedback, which allows working out of sight for short periods of time.

Communication Between Personnel

Effective, continuous communication must be established between:

Standby Person and Entrant

- Primary channel: visual.
- Backup channel: verbal (voice; radio or hard-wired system).
- Third channel: Consider using an airhorn (repeated blasts in emergency from either party).

Standby Person and Onsite Emergency Rescue Team

Establish a good two-channel communication system to contact ERT before the work starts.

- Check radio channel, battery and test.
- Check mobile phone battery and coverage.
- Check onsite internal landline requirements.
- Confirm and record numbers.
- Prenotification of ERT may be required before work starts.

NOTES

CONFINED SPACE PERMITS AND PROCEDURES

Confined Space Entry Permit

A confined space entry permit is a contract between the person in control of the place of work (referred to as the **permit issuer**) and the person in charge of the team responsible for carrying out the work scope (the **permit receiver)**.

- The permit must be signed by the issuer to allow the work to go ahead, and again when the work is finished. For a permit to be effective, it must be used as a communication tool.
- ALL changes to the work scope, job safety analysis (JSA) or permit should be authorised by the permit issuer and the permit receiver. Major changes may require escalation to higher authority to proceed.

REMEMBER: THE ISSUE OF A PERMIT ALONE DOES NOT MAKE A JOB SAFE.

The purpose of a permit is to ensure the job is carried out safely.

Other examples of work permits include:

- Hot work (welding, cutting, grinding etc).
- Energy Isolation (lock out, tag out or LOTO).
- Work at height (where a fall is possible either above or below ground).
- Excavation/penetration.

Permit Information

- Who is authorised to enter confined space.
- Location of work.
- What & how the work will be done.
- What monitoring is required **and** must include test results.
- What control measures are required & record they are in place.
- Appropriate PPE that is to be issued.
- The rescue/emergency procedures are, and who is in the rescue team.

  about any substances and equipment that will used.
- Who the stand-by personnel are.
- How long the permit is valid for.

Additional Work Permits and Notifications

Additional permits are usually needed for any potentially dangerous or complex work that will be done inside the confined space

Examples include:

- Where plant and equipment must be isolated.
- Entry into contaminated or flammable atmospheres.
- Where breathing equipment is needed.
- Where heat stress is a significant hazard.
- Where scaffolding is needed.

Supporting Documents

The following key elements should be covered in the policy and procedures for confined space:

- A map or plan identifying all confined spaces.
- Hazard identification, risk assessment procedures and forms.
- Atmospheric testing and monitoring procedures and forms.
- Procedures for conducting tasks in confined spaces.
- Training plans.
- Inspections and audits and accident investigations.
- Emergency rescue plans.

Roles and Responsibilities

Position	Permit Issuer (Authorising Officer)
Role	Initiates the permit for commencement, establishes entry conditions, and both initiates and concludes the permit.
Responsibilities	▷ Specifies the safe conditions of entry. ▷ Checks for other teams affecting each other. ▷ Works with team leader. ▷ Often involved with risk assessment. ▷ Ensures control measures are in place. ▷ Ensures workers are briefed. ▷ Withdraws and may change permit if conditions not met or if new uncontrolled hazards arise. ▷ Ensures equipment and resources are available for the work to be undertaken safely.

Position	Permit Receiver (Team Leader)
Role	Verifies that the job scope is carried out in compliance with the conditions specified in the permit.
Responsibilities	▷ Ensures entry conditions are fully complied with ▷ Ensures that all personnel are competent and capable of doingthe work ▷ Briefs workers (contractors, sub-contractors, employees) ▷ Ensures emergency response procedures are in place ▷ Ensures continuous monitoring of the atmosphere ▷ Completes risk assessment ▷ Overall control of the work and emergency response ▷ Completes entry permit and returns it to permit issuer.

Position	Stand-by Person
Role	Oversees the confined space entry, upholds communication, and executes the emergency plan.
Responsibilities	▷ Constant communication with entrant ▷ Access to emergency services/rescue team ▷ May carry out non-entry assisted rescue; ▷ Ensures area safety ▷ Ensures hazard controls are maintained ▷ Raises alarm and initiates rescue procedures ▷ Works with team leader to complete permit ▷ Completes entry log and gas test results ▷ First-aid duties.

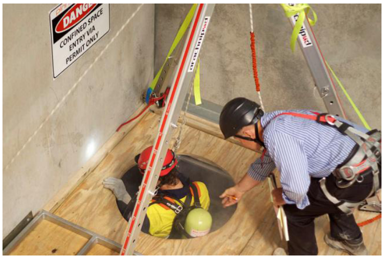
Position	Confined Space Entrant
Role	Completes the task, maintains communication and follows the rescue plan if required.
Responsibilities	▷ Must work safely and prevent harm to others ▷ Maintains communication with standby person ▷ Signs the permit on and off ▷ Must be competent and briefed ▷ Applies personal lockout tags and locks ▷ Understands what to do in an emergency ▷ Evacuates if known or new hazards arise or conditions change ▷ Uses personal gas detection ▷ Wears and uses appropriate PPE and equipment.

Permit Issuer:

Team leaders self-issuing permits can be a less robust practice. A designated permit issuer, who is aware of all work conflicts, holds a more authoritative position of overall control due to their comprehensive perspective. Self-issuing lacks the safety net of validation and may risk devolving into a mere 'tick box' exercise.

Permit Receiver:

NOTE: The permit receiver may also be the standby person or entrant.



Hot Works Permit

According to AS 2865-2009, hot work is defined as activities such as welding, thermal or oxygen cutting, and heating, which involve fire-producing or spark-producing operations, thereby increasing the potential risk of fire or explosion.

Potential Hazards of Hot Work:

- Drastic changes in temperature.
- Alterations in the surrounding atmosphere.
- Potential impact on oxygen levels.
- Possibility of igniting flammable gases or vapors, leading to fires or explosions.

Examples of Hot Work:

- Arc, plasma, or gas cutting.
- Various welding processes (arc, MIG, TIG, plasma, etc.).
- Grinding and cutting using air or electrically operated equipment.
- Use of non-intrinsically safe electrical equipment like lighting, torches, and radios.
- Arcing electrical devices.
- Open flames.
- Hazardous Conditions During Hot Work:

Hot Works Permit

The workspace may exhibit the following risky conditions:

- Presence of products or volatile liquids releasing flammable gas or vapor.
- Possible presence of hydrogen if a metal vessel previously contained acid or alkaline substances.
- Contaminants like sludge, scale, resin, gum, varnish, bitumen, or non-volatile oil, which may emit flammable gases when heated.
- Accumulation of dust or dust-producing substances, such as coal or wheat, which can lead to violent explosions or smoldering.
- Internal coatings releasing flammable and toxic vapors when heated.
- Concurrent hazardous activities during shutdowns and maintenance, such as painting, dust, or fumes in the same vessel or area.

Hot Works Precautions

NOTE: A permit for hot work must be issued when conducting tasks involving welding, cutting, or similar activities within, on, or near a confined space to effectively manage the associated high-risk factors.

The following essential precautions and controls must be checked off on the hot work permit:

- Ensure the area is devoid of all combustible and explosive materials within a 15-meter radius.
- Cover all drains within a 15-meter range with a fireproof blanket.
- Verify and position fire extinguishers for easy accessibility.
- Have a water hose on-site, tested, and continuously running.
- Contain all sparks originating from work at least two meters above the ground.
- Keep gas cylinders at a minimum distance of eight meters from drains.
- Ground the welding machine directly and in close proximity to the welding ob.
- Isolate the electrical trace on pipes.
- Strip coatings for a minimum distance of 150mm.

APPENDICES

Appendix 1: Glossary

Airborne Contaminant: Any contaminant present in the air that may be harmful to persons.

Atmospheric Monitoring: The continuous measurement of oxygen concentration or airborne contaminants over an uninterrupted period of time.

Atmospheric Testing: The measurement of oxygen concentration or airborne contaminants that is not continuous.

Breathing Zone: A hemisphere of 300mm radius extending in front of the worker's face and measured from the midpoint of an imaginary line joining the ears.

Competent Person: A person who has, through a combination of training, education and experience, acquired knowledge and skills enabling that person to perform a specific task correctly.

Confined Space: An enclosed or partially enclosed space that is not intended or designed primarily for human occupancy, within which there is a risk of one of more of the following:

- Oxygen concentration outside the safe oxygen range
- Concentration of airborne contaminant that may cause impairment, loss of consciousness or asphyxiation
- Concentration of flammable airborne contaminant that may cause injury from fire or explosion
- Engulfment in a stored free-flowing solid or a rising level or liquid that may cause suffocation or drowning.

Contaminant: Any dust, fume, mist, vapour, biological matter, gas or other substance in liquid or solid form, the presence of which may be harmful to persons.

Engulfment: The immersion or envelopment of a person by a solid or liquid (e.g. grain, sugar, flour, sand, coal, fertiliser and any other substances in a powder or granular form) that is stored within the confined space.

Entry (to a confined space): When a person's head or upper body is within the boundary of a confined space. (Note: Inserting an arm for the purpose of atmospheric testing is not considered as entry to a confined space).

Explosive Limits: (Refer also to Flammable Range)

- Lower Explosive Limit (LEL): Concentration of a flammable contaminant in air below which the propagation of a flame does not occur on contact with an ignition source.
- Upper Explosive Limit (UEL): Concentration of a flammable contaminant in air above which the propagation of a flame does not occur on contact with an ignition source.

NOTE: The terms 'explosive limit' and 'flammable limit' are equivalent.

Flammable: Used to describe materials which ignite more easily than others, and as such are more dangerous and more highly regulated. Less easily ignited materials or those which burn less vigorously are commonly referred to as being combustible.

Flammable Airborne Contaminant: Any dust, fume, mist, vapour or gas present in the air at concentrations that can propagate a flame on contact with an ignition source.

Flammable Range: (Refer also to Explosive Limits): Range of flammable airborne containment (percentage by volume) in air at which an explosion can occur upon ignition. Expressed as the range found between the Lower Explosive Limit (LEL) and Upper Explosive Limit (UEL).

Fumes: Very small solid, airborne particles formed by condensation or incomplete combustion and chemical processes.

Gas: A state of matter with low density and viscosity compared to liquids and solids. Can be formed from individual atoms (argon) or molecules (carbon dioxide).

Heat Stress: Heat stress is considered a significant hazard and relates specifically to the environment being worked in. It is the net load on the body from metabolic heat production and external environmental factors (i.e. temperature, humidity, radiant heat transfer, air movement, clothing).

NOTE: Heat stress may be defined as the effects on the body of working in a hot environment.

Heat Strain: Heat strain is considered as serious harm. It is the consequence of exposure to environmental heat stress on a person's mind and body. It can result in either acute or chronic harm.

The body can regulate its core temperature at 37°C (+2°C). A core body temperature outside of this range may cause death or serious injury. An increase in temperature may lead to heat strain (hyperthermia) whereas a decrease in temperature may result in cold strain (hypothermia).

- Hyperthermia: Elevated body temperature due to failed thermoregulation. It occurs when the body produces or absorbs more heat than it can dissipate.
- Heat Exhaustion: Sweating out of the body's fluids, including electrolytic salts vital to the nervous system, results in aggressive mood changes and fainting, easily treated if caught early.
- Heat Stroke: A core temperature above 40°C results in a failure of the thermal regulating system. Sweating ceases and brain damage and death will follow if not treated rapidly.

Hot Work: Welding, thermal or oxygen cutting, heating, including fire-producing or spark-producing operations that may increase the risk of fire or explosion.

Impairment: The condition of being unable to safely conduct a task as a consequence of physical or mental unfitness.

Intrinsically Safe: The electrical circuit and wiring within a device cannot cause any sparking or arcing, store sufficient energy to ignite a flammable gas or vapour, or produce a surface temperature high enough to cause ignition.

Safe Oxygen Range: A concentration of oxygen in the atmosphere having a minimum of 19.5% by volume and a maximum of 23.5% by volume, under normal atmospheric conditions.

NOTE: At pressures significantly higher or lower than normal atmospheric pressure, expert advice should be sought.

Self-Contained Breathing Apparatus (SCBA): A portable respirator that supplies oxygen, air or other reparable gas from a source carried by the user.

Simple Asphyxiate: Gases and vapours, when present in sufficient quantities in air, behave as asphyxiates ‘simply’ by reducing the concentration of airborne oxygen by dilution or displacement.

Standby Person: A competent person assigned to remain on the outside of, and in close proximity to, the confined space and capable of being in continuous communication with and, if practicable, observing those inside. In addition, where necessary, the competent person may operate and monitor equipment for the safety of personnel in the confined space and initiate emergency response.

Task-Related Hazard: In respect of confined space, exposure to a hazard because of the task being conducted on or in the confined space.

Vapour: The gaseous form of a substance which normally exists as a liquid or solid. (Normal conditions are 25°C and 760mm Hg pressure).

Volatile Organic Compounds (VOCs): Organic compounds that contain carbon (such as gasoline, benzene, coal) that easily become gases or vapours. VOCs can be highly toxic.

Written Authority: The confined space entry permit. A document that gives permission for entry into a confined space and the conduct of tasks associated with the confined space.

Appendix 2: Escape Breathing Apparatus

Constant Flow Escape Breathing Apparatus Donning

1. Remove hood from bag

- Pull protective bag open by seperating velcro seal.
- Remove hood by pulling outward away from bag.
- Air should start flowing automatically; if not, ensure pin has been released from top of reducer

2. Place hood over head

- Separate neck seal with both hands
- Place hood over head with clear visor forward
- Ensure nasal pocket covers mouth and nose
- Inhale, and breath normally.

3. Escape the area

- Ensure mask remains in place
- Immediately escape area.

Appendix 3: Gas Detectors - Operator Instructions

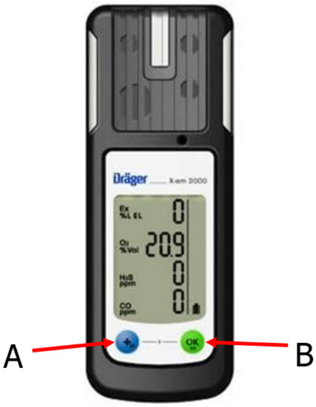
BW Gas Alert Micro Clip/Micro Clip XT

ACTION	HOW	DISPLAY
TURN ON (Must be done in fresh air)	Press button **A**	**TWA** alarm settings **STEL** alarm settings **INSTANT** alarm settings low **INSTANT** alarm settings high **TEST** tests circuitry and sensors **TEST OK** **AUTO ZERO** must be done in fresh air **CAL DUE DAYS** number of days till next calibration date **MEASURING MODE** ready for use
PEAKS	Press button **A** twice	**TWA** peaks **STEL** peaks **PEAKS** high and lows **RESET** defaults back to measuring mode after approx 3 seconds
CLEAR PEAKS	Press button **A** (while **"reset"** on screen)	**RESET** Double beep then defaults back to measuring mode
TURN OFF	Press and hold button **A**	Counts down 3-2-1, then switches off

BW Gas Alert Quattro

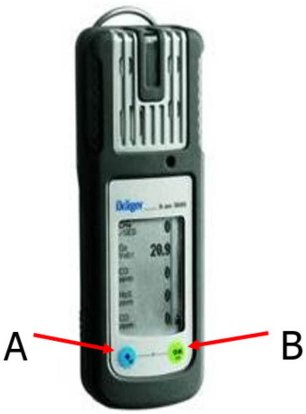
ACTION	HOW	DISPLAY
TURN ON (Must be done in clean air)	Press button **A** (2 secs)	**TWA** alarm settings **STEL** alarm settings **INSTANT** alarm settings low **INSTANT** alarm settings high **TEST** tests circuitry and sensors **TEST OK** **AUTO ZERO** must be done in clean air **CAL DUE DAYS** number of days till next calibration date **MEASURING MODE** ready for use
PEAKS	Press button **A** twice	**TWA** peaks **STEL** peaks **PEAKS** high and lows **RESET** defaults back to measuring mode after approx 5 seconds
CLEAR PEAKS	Press and hold button **A** (while **"reset"** on screen)	**RESET** 3 audible beeps over 3 seconds, then defaults back to measuring mode
TURN OFF	Press and hold button **A**	Counts down 3-2-1, with 3 audible beeps, then switches off

Drager X-am 2000



ACTION	HOW	DISPLAY
TURN ON (Must be done in fresh air)	Press and hold button **B** (Approx 3 seconds)	**INSTANT** alarm settings: A1 low & A2 high **TWA** & **STEL** alarm settings **CAL DAYS** number of days till next calibration date **Measuring mode** Wait till caution icon goes out before use
PEAKS	Press and hold button **B** (Approx 2 seconds) Press button **B** again Press button **B** again	**Peak values** will be shown **TWA** peaks will be shown **STEL** peaks will be shown If button **B** is not pressed at any time, it will return to Measuring mode after approx. 10 seconds
FRESH AIR CALIBRATION	Press button **A** 3 times Press button **B** to select Press button **B**	Clean air icon shows Real values are shown (flashing) **OK** appears in screen Clean air cal is finished
TURN OFF	Press and hold buttons **A** & **B** (simultaneously)	Unit will Count down 3-2-1, then switch off

Drager X-am 5000



ACTION	HOW	DISPLAY
TURN ON (Must be done in fresh air)	Press and hold button **B** (Approx 3 seconds)	**INSTANT** alarm settings: A1 low & A2 high **TWA** & **STEL** alarm settings **CAL DAYS** number of days till next calibration date **Measuring mode** Wait till caution icon goes out before use
PEAKS	Press and hold button **B** (approx 2 seconds) Press button **B** again Press button **B** again	**Peak values** will be shown **TWA** peaks will be shown **STEL** peaks will be shown If button **B** is not pressed at any time, it will return to Measuring mode after approx 10 seconds
QUICK MENU PEAKS	Press button **A** 3 times Press button **A** till peaks are Highlighted Press button **B** to select peaks Press button **B** for 5 sec to delete peaks Press button **B**	Possible functions of quick menu are shown Bump Test Clean air cal Display peaks values Peak reading will show Readings will return to normal Returns to measuring mode
TURN OFF	Press and hold buttons **A** & **B** (simultaneously)	Unit will Count down 3-2-1, then switch off

Appendix 4: Limits of Flammability

Limits of flammability are measured in percentage of volume.

GAS	LEL	UEL
Acetone	2.5	12.8
Acetylene	2.5	80.0 (100 at pressure)
Benzene	1.2	7.9
Butane	1.6	8.4
n-Butyl acetate	1.7	7.6
Ethane	3.0	12.5
Ethanol	3.3	19.0
Ethylene oxide	3.0	100.0
Gasoline (100 octane)	1.4	7.6
Heptane	1.05	6.7
Hexane	1.1	7.5
Hydrogen	4.0	75.0
Isopropyl alcohol	2.0	12.0
Methane	**5.0**	**15.0**
Methyl ethyl ketone	1.4	11.4
Pentane	1.5	7.8
Propane	2.1	9.5
Propylene oxide	2.3	36.0
Styrene	0.9	6.8
Toluene	1.1	7.1
Xylene	0.9	6.7

Appendix 5: Vapour Density

Lighter than Air		Equal to Air		Heavier than Air	
Carbon monoxide	0.97	Ethane	1.0	Oxygen	1.1
Ethylene	0.97	Nitric oxide	1.0	Hydrogen sulfide	1.2
Hydrogen cyanide	0.9			Hydrogen chloride	1.3
Acetylene	0.9			Carbon dioxide	1.5
Ammonia	0.8			Ethylene oxide	1.5
Methane	0.6			Propane	1.6
Hydrogen	0.1			Nitrogen dioxide	1.6
				Ethanol	1.6
				Methyl mercaptan	1.66
				Acetone	2.0
				Butane	2.0
				Sulphur dioxide	2.2
				Pentane	2.5
				Chlorine	2.5
				Benzene	2.6
					3.0
					3.1
					3.7
					4.0
					4.7

OTHER IMPAC COURSES YOU MAY BE INTERESTED IN ARE:

HSR STAGE 2:

This course has been designed for students to understand how to conduct both a risk assessment and a basic incident investigation.

JOB SAFETY ANALYSIS

Job Safety Analysis involves looking at a task and considering what is the safest way to complete it. This course explains key processes, identifying hazards and controls and how to undertake a job safety analysis for a specified job.

FIRE EXTINGUISHER

This course will equip you with knowledge about various fire extinguisher types and practical abilities to effectively extinguish fires using the appropriate equipment. Additionally, you will stay informed about recent advancements in effective fire suppression techniques.

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Our cloud-based software solutions are designed to provide risk management processes to meet health and safety requirements and keep people safe. Choose between our cost effective, **set-up-and-go solution RM Express** - ideal for small to medium organisations; and **Risk Manager, with its fully customisable range of modules** which can be tailored to the needs of larger organisations.

CONSULTING

We work alongside businesses and organisations to understand their challenges and opportunities. Our hugely experienced consulting team assess, advise, investigate and **deliver relevant and practical solutions**, applying a sensible risk management approach to health and safety.

PREQUAL

Our **pan-industry solution to contractor prequalification** and ongoing management. We cater for both individuals needing contractor prequalification and companies wanting to manage all their contractors in one easy to navigate platform.

VRCOMPETENCY

Our innovative virtual reality programme to quickly and effectively upskill operators of motorised vehicles and machinery in a safe and risk free environment. Our courses accelerate training times, improve and certify skills and offer continuous learning.

TALENTBANK

With our unrivalled industry experience and wide network of talent, our **specialist recruitment service** helps to connect the right H+S people to an organisation's contract or permanent roles. We fully understand our clients' resourcing needs and know the best way to help H+S professionals build a better career.

SAFEWORX

We supply a comprehensive range of quality standards appraised **workwear, personal protection and safety equipment**, online and at retail branches nationwide. Our expert team partner closely with customers to develop innovative safety products to address gaps in high risk industries.

To discuss any of IMPAC's H+S services
contact 0800 246 722

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