SITETRAIN

NATIONALLY RECOGNISED TRAINING

# MSMWHS217 Gas test atmospheres

## Learner Guide

RTO 41466

www.sitetrain.com.au

# Introduction

This manual is designed to complement your training on shift and instructions given by your shift Trainer or Supervisor. You must also reference and become competent in all the associated safe operating procedures for the use and handling of gas detection equipment. Use this manual as a reference point if you need to brush up on the theory and reasons why things are happening in your circuit and over time they will become skills that you can apply to your ever day work and ensure you are a safe and efficient operator of the required gas detection equipment.

You will be ultimately assessed on your competence in this area once a discussion has been held with your Supervisor, Superintendent, Training Supervisor and yourself to ensure you are capable and comfortable to sit the assessment criteria.

Assessment criteria is:

1. Theory Examination

2. Practical Examination of the critical aspects of Gas Detection

3. Verbal Questioning

This is not designed to be a test but more of a snapshot of your abilities and competence and can be completed over a day or weeks. This time frame will depend on you, shift manning levels and the Training Supervisors' availability.

The mining industry is a very rewarding career and can take you around Australia or even the world. The more you learn now will ensure you have a great future ahead.

***"Good Luck"***

# Legislative Requirements

## Western Australia

### Mines Safety and Inspection Legislation

On 12 July 2018 the WA Government announced the development of a modernised Work Health and Safety Bill for Western Australia which is based on the national Work Health and Safety Act. This Bill will replace three acts, the *Occupational Safety and Health Act 1984*, *Mines Safety and Inspection Act 1994*; and *Petroleum and Geothermal Energy Safety Levies Act 2011*.

The development of the Bill will involve extensive consultation with stakeholders and the community prior to introduction into State Parliament.

To keep up to date with the progress subscribe to WorkSafe newsletters.

## NSW

### Work Health and Safety Legislation

The Work Health and Safety (WHS) Act 2011 and the Work Health and Safety (WHS) Regulation 2011 apply to all workplaces in NSW. This includes mining workplaces.

### Work Health and Safety (Mines) Legislation

The *Work Health and Safety (Mines) Act 2013* and Work Health and Safety (Mines) Regulation 2014 apply to all mining workplaces in NSW.

They support the WHS Act and WHS Regulation and provide additional provisions for work health and safety (WHS) issues unique to mines.

The WHS (Mines) legislation was drafted based on the national model WHS Regulations for mining and the additional tri-state mining provisions agreed by NSW, Queensland and Western Australia.
The WHS (Mines) legislation will commence on 1 February 2015.

The following laws will be replaced by the WHS (Mines) legislation when it commences:

- Coal Mine Health and Safety Act 2002
- Coal Mine Health and Safety Regulation 2006
- Mine Health and Safety Act 2004
- Mine Health and Safety Regulation 2007

http://www.resourcesandenergy.nsw.gov.au/miners-and-explorers/safety-and-health/legislation

Check the link above to ensure you have the most up to date legislative information available.

# Customers

In each section of the plant or process area each operator has a “Customer” a customer is defined as:

*A customer is some person or organisation that uses an **OUTPUT** from a different person or organisation. Customers are defined as internal and external to an organisation. External customers are most common in sales where a company sells a product to a customer.*

***INTERNAL CUSTOMERS ARE PERSONS OR DEPARTMENTS WHO RELY ON OUTPUT FROM ANOTHER DEPARTMENT OF THE SAME ORGANISATION TO ACCOMPLISH THEIR OWN FUNCTION!***

Each section in the process plant has customers either upstream or downstream of their section of operation. When you run your section you not only have your immediate area to be concerned about, but also what actions/inactions you do in your area which may impact on others in the process.

**Example:** The mining Supervisor making decisions about how many trucks to run on Sunday night to the crusher will impact on the tonnage crushed, stockpile levels, grinding output due to stockpile levels, coarse/fine ore distribution.

The Grinding Operator who misses a blocked cyclone for a couple of hours will impact on the operation of the Grinding circuit and possible downtime; a partially blocked cyclone will impact on grind size distribution and the overall plant recovery rate.

Developing relationships with and considering your upstream and downstream customers during your shift will enable you to have a broader concern for the process while ensuring you communicate and acknowledge issues, problems or efficiencies throughout the plant. This is a skill which to be an effective team member you must develop and embrace to be a more effective and valuable team member.

# Area Parameters

Each area of the plant has Parameters which when adhered to ensure the most efficient operation of your circuit but are also designed to ensure the efficient operation of the sections up or downstream of your section.

**Example:** The gap setting on the primary crusher, which controls the size of the product going to the stockpile, is critical for the SAG mill. If the product from the primary crusher is allowed to get too coarse (big) then it will impact on tonnages through the plant.

**Summary:** Identify your upstream and downstream customers and ensure you have open lines of communication to them at all times remembering they have operational issues as well.

Run your section to the best of your ability. Always remember that anything you do in your section will impact on the next section in some way.

Parameters are designed to run the plant at its most efficient given the evidence and data at the time. If you have an issue with a parameter addresses it with your supervisor and your upstream customer they may shed light on why it is what it is.

**Every person on site is an important part of our business, no matter what they do!**

# Planning and Preparing for Gas Test Atmosphere

## Documentation

Documentation plays an important role in the mining industry. Some of the paperwork is legislated against and as such must be completed to stay compliant.

Some of the paperwork must be completed from a business point of view to record and analyse information to improve the process. It is a vital part of your position regardless of where you are in your career to:

- Ensure you understand the need for the paperwork
- Know if it is a legal requirement or a business requirement
- Have an understanding of the information and who uses it
- Complete the documentation correctly and clearly with the relevant information
- Be able to access, interpret and apply the information from within the documentation

Examples of site documentation which you may be exposed to are:

- Incident/ Accident reporting
- Job Hazard Analysis (JHA, JSA, JSEA)
- Sectional log sheets
- Diaries, event logs
- Project spreadsheets
- Rosters
- Area Standard Operational procedures
- Theory Manuals
- Technical papers
- Equipment Manuals
- Handover notes
- Isolation lists
- Permits – Confined Space, Power line access, Gold room access

## PPE

PPE is the last line of defense against any hazard (Hierarchy of Controls).

PPE relies on the wearer to:

- Be trained in its application
- Follow the instructions of the manufacturer
- Identify when it is needed
- Signage
- Hazard awareness
- Choose the correct PPE for the hazard faced
- Use the chosen PPE correctly to ensure maximum benefit
- Clean and store correctly once used

## TYPES OF PPE

- Hearing protection
- Head protection
- Hot work and Heat emitting protection
- Feet and Legs
- Clothing – Hi Vis
- Chemical specific protection
- Arc flash protection
- HV Gloves

## PPE STANDARDS

### Hearing Protection

- National Code of Practice for Noise Management and Protection of Hearing at Work [NOHSC:2009 (2004)].
- Australian Standard AS/NZS 1269: Occupational noise management.
- Australian Standard AS/NZS 1270: Acoustics – Hearing protectors.

### Head Protection

- Head Protection is covered by the following standard:
  - AS/NZS 1800:1998 Occupational protective helmets - Selection, care and use
  - Some attachments will have applicable standards
- Hearing standard - AS/NZS 1269.
- Eye protection – AS/NZS1337.1:2010.
- Heat Protection.
- Arc protection.
- Ensure the attachment meets the required standards specific to the attachment used.

### Eyes and Face

- Australian Standard AS/NZS 1337

Australian standard AS/NZS 1337.1:2010 (Personal eye protection - Eye and face protectors for occupational applications) for Medium Impact (the highest possible rating for safety eyewear in Australia).

### Prescription Glasses

- Prescription glasses must fit the same criteria as safety glasses:
  - Seal against face
  - Air circulation
  - Satisfactory vision and comfort
- If this cannot be gained by Safety glasses then mono goggles or similar must be worn.
- Mono goggles are to be worn over prescription glasses if they do not meet this criteria.
- In the case prescription glasses are damaged at work an incident report must be completed.

**Gloves**

- AS/NZS 2161.2:1998 General Requirements.
- AS/NZS 2161.3:2005 Protection against mechanical risks.
- AS/NZS 2161.4:1999 Protection against thermal risks (heat and fire).
- AS/NZS 2161.5:1998 Protection against cold.
- AS 2161.6-2003 Protective gloves for fire fighters - Laboratory test methods and performance requirements.
- AS/NZS 2161.10.3:2005 Determination of resistance to permeation by chemicals.

**Clothing**

- AS/NZS 4602.1:2011 Hi Vis safety garments.

**Footwear**

- AS/NZS 2210 Occupational Protective Footwear

**Note**

- Understand the hazards you are faced with
- Understand the PPE protection level that is needed
- Be familiar with your PPE, strengths and weaknesses
- Ensure it Fits and YOU are comfortable with it
- NOT all PPE is the same
- ALWAYS choose the highest level of PPE for any task

# EMERGENCY PREPAREDNESS

Each site will have its own procedure for raising and handling an emergency event on site. You must understand how these procedures work and the numbers associated.

Direct landline phone number
Mobile Number if available
Radio channel (Nightshift may have a different number)

The procedure will almost always reflect the following:

- Exact location of the incident
- Type of incident/accident
- How many casualties
- What type of injuries
- Name of person
- Contact number of person reporting incident

Gather as much information as possible

Remain Calm!

# HAZARD AWARENESS

***A hazard is something with the potential to cause you harm physically or mentally. Can also damage or destroy machinery and plant, can impact adversely on the environment***

- Inherent Risk is the risk associated with an unwanted event without the existing controls being taken into account.
- Likelihood is the chance of a particular unwanted event occurring.
- Residual Risk is the risk associated with an unwanted event after consideration and evaluation of the existing control measures.
- Risk is the combination of the potential severity arising from an unwanted event/hazard together with the likelihood of the unwanted event actually occurring

## GENERAL HAZARD IDENTIFICATION PROCESS

1. IDENTIFY THE HAZARD
2. ASSESS THE RISK
3. CONTROL THE HAZARD
4. MONITOR / REVIEW / UPDATE

## JOB HAZARD ANALYSIS (JHA)

Is a structured approach for identifying potential hazards in a task and devising control measures. Because a JHA considers actions (behaviours) as well as physical and environmental conditions, it is a good way to increase safety awareness and achieve sustainable improvements in safety performance.

JHAs are a good way to formulate safe work procedures (SWPs) when several JHAs have been completed on the same task.

JHAs can be used to identify and control the hazards for all work that is non-routine or not covered by a SWP.

## THE HIERARCHY OF CONTROLS

The hierarchy of controls should be applied in the following order:

**ELIMINATE:** The complete elimination of the hazard.
**SUBSTITUTE:** Replacing the material or process with a less hazardous one.
**ENGINEER:** Redesign the equipment or work processes.
**ISOLATE:** Isolating the hazard by guarding or enclosing it.
**ADMINISTRATE:** Providing control such as training procedures etc.
**PERSONAL PROTECTIVE EQUIPMENT:** Use properly fitted PPE where other controls are not practical.

## HAZARD REPORTING

At any time on the job you notice a hazard or potential hazard, it is your “duty of care” to stop and eliminate the hazard. If you can eliminate the hazard by moving it, do so. Otherwise it must be reported to your supervisor immediately.

Depending on the type of hazard the company will have different reporting procedures to follow. If unsure your supervisor will help with the reporting process.

Any accidents or incidents on site must be reported to your supervisor. There are company hazard and incident report forms that will need to be filled in.

## COMMUNICATION SYSTEMS

There is a range of communication systems used in all workplaces.

These may include:

- Radio
- Hand signals
- Verbal communications
- Mobile phones
- E-mail
- Notices and memos posted on notice boards

When communicating with other workers on site, be sure to use clear and concise messages, especially when talking to work mates. If you are unsure of any instructions, ask them to be repeated so they are clearly understood.

## AUXILIARY EQUIPMENT

Is equipment which helps you achieve the requirements in your area of responsibility. These may include but not limited to:

- Computers
- Front End Loaders
- Skid Steer loaders
- Forklifts
- High Pressure water cleaners
- Radios
- Computers
- Light Vehicles
- Compressed Air
- Tools

These pieces of auxiliary equipment allow you to complete your work which is the safe and efficient operation of an area of a mineral processing plant. Your role is very diverse and can be made up of:

- Production targets
- Safety and housekeeping targets
- Communicating with other departments
- Vehicles for transportation to carry out inspections and work in a large area
- Machinery for more efficient operation of plant
- Identifying and Reporting hazards

# ELEMENTS AND PERFORMANCE CRITERIA

## Element 1

Prepare for gas testing

***Performance Criteria***

1. Determine type of gas/atmosphere to be tested
2. Select and calibrate equipment in accordance with procedures
3. Determine gas testing regime/sampling pattern required
4. Identify hazards from possible atmosphere contaminants
5. Implement hazard control measures, including use of appropriate personal protective equipment

## Element 2

Test gas

***Performance Criteria***

1. Use gas testing equipment to test gas as required
2. Interpret and report readings
3. Monitor gas on an ongoing basis as required
4. Take required action(s) if readings are unacceptable

## Element 3

Maintain equipment

***Performance Criteria***

1. Clean and maintain gas testing equipment in accordance with procedures
2. Inspect and fault find monitoring equipment in accordance with procedures
3. Return gas testing equipment to required location and in required condition
4. Maintain records of tests and results in accordance with procedures

# SECTION 1

# DETERMINE GASES TO BE DETECTED

There are three main areas of concern associated with atmospheres within confined spaces

1. Suffocation - by oxygen deficiency
2. Poisoning - by toxic gases
3. Explosion - from combustible gases

## Suffocation

The safe oxygen level required is:

- Minimum content in the air – 19.5%
- Maximum content in the air – 23.5%

Serious injury may result from exposure to oxygen deficient atmospheres.

Where an atmosphere is oxygen enriched, the risk of combustion and explosion is increased considerably.

## Poisoning

Atmospheres of confined spaces are tested prior to entry. Levels of contaminants are determined and compared to known acceptable exposure levels

## Threshold Limit Values (acceptable exposure levels)

The TLV is the airborne concentration of a particular substance in a person's breathing zone, exposure to which, according to current knowledge, should not cause adverse health effects nor cause undue discomfort to nearby persons at all.

**TWA** **Time Weighted Average**
This is what nearly all people can be exposed to for 8 hours per day - 5 days per week.

**STEL** **Short Term Exposure Level**
This is the maximum allowable level of gas that a person can be exposed to for 15 minutes with a one hour break and not repeated more than four times a day.

**PEAK** **Maximum (or Peak) Level**
**Evacuate**

**The TWA for more common gases are:**

- Carbon Dioxide 5000ppm
- Carbon Monoxide 35 ppm
- Hydrogen Sulphide 10 ppm

- Ammonia 25 ppm
- Chlorine 0.5 ppm

## Explosion

Explosive atmospheres are identified by the presence of flammable contaminants. Lower explosive limits are used to determine safety to enter.

The concentration in air at which a gas is combustible is referred to as the Explosive Limit.

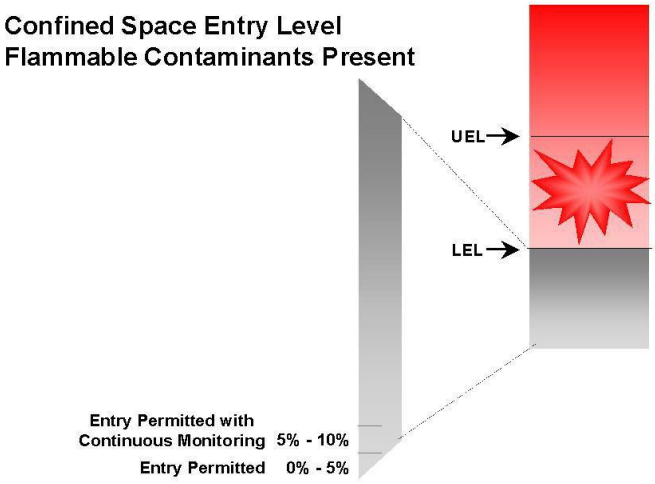
**UEL Upper Explosive Limit** - the highest concentration of a gas that can lead to an explosion in the presence of air and an ignition source.

**LEL Lower Explosive Limit** - the lowest concentration of a gas that can lead to an explosion in the presence of air and an ignition source.

Where the concentration of flammable contaminant is less than 5% of the LEL, the space is safe to enter.

Where the concentration has been found to be greater than 5% but less than 10% of the LEL, work may continue providing that continuous monitoring is in place at all times while persons are present in the space.

Where the concentration exceeds 10% of the LEL all persons are to be removed.



## OXYGEN DEFICIENCY

| | |
|---|---|
| 21% | Normal concentration in the air |
| 16% | Rapid breathing, pulse rate increased |
| 14% | Loss of muscular coordination. Breathing laboured. Abnormal fatigue. Cyanosis developing (blue lips etc.) |
| 10% | Nausea, headache and vomiting. Unable to move freely. Liable to lose consciousness Very rapid breathing |
| 6% | Convulsive movements, gasping breathing, heart action and breathing may cease |

## CARBON DIOXIDE

| | |
|---|---|
| 10% | Death within a few minutes |
| 8% | Headache, vomiting, dizziness, breathing difficulties after a short time |
| 5% | Vomiting, dizziness, disorientation after 30 minutes |
| 3% | Breathing rate doubles |
| 2% | Rapid deep breathing. Tingling sensation across the body |
| 0.03% | Normal concentration in the air |

## CARBON MONOXIDE

| | |
|---|---|
| 1.28% | Unconscious after 2 -3 breaths danger of death in 1-3 minutes. |
| 0.64% | Headache and dizziness in 1-2 minutes Unconsciousness and danger of death in 10-15 minutes. |
| 0.32% | Headache and dizziness in 5-10 minutes Unconsciousness and danger of death in 30 minutes. |

## HYDROGEN SULPHIDE

| | |
|---|---|
| 0.10% | Death occurs almost immediately due to paralysis of the respiratory system |
| 0.07% | Depression, stupor, unconsciousness and death |
| 0.06% | Serious symptoms within a few minutes. Gas attacks the lining of the air passages |
| 0.05% | The highest % that can be breathed without causing death - serious effects after 30mins |
| 0.02% | Within 10 minutes intense irritation of the eyes and throat. Unbearable after 30mins. |
| 0.01% | Convulsive movements, gasping breathing, heart action and breathing may cease |

| Gas | Oxygen | Nitrogen | Carbon Dioxide | Carbon Monoxide | Hydrogen Sulphide | Methane | Ammonia | Sulphur Dioxide |
|---|---|---|---|---|---|---|---|---|
| Symbol | O2 | N2 | CO2 | CO | H2S | CH4 | NH3 | SO2 |
| Dangers | Elevated O2 levels increases the fire risk & is combustible with grease & oil. Lack of O2 will cause death. | Breathed in at high partial pressures, can have a narcotic effect. | Can displace O2. Increases the respiratory rate, leading to hyperventilation and eventually O2 deficiency. | Highly toxic at low levels. Chemically acts on the blood and stops O2 uptake. | Highly toxic at low levels, this gas attacks the part of our brains that controls our breathing. Can cause respiratory failure. Will greatly decrease our sensitivity of smell. | Highly combustible & can displace O2 | Irritation of eyes, nose and throat, severe respiratory tract irritant can cause pulmonary edema | irritation of the eyes, nose and throat, choking and coughing headache, general discomfort and anxiety lung damage |
| Typical Features | Colourless Odourless Tasteless | Colourless Odourless Tasteless | Acrid smell. Taste similar to soda water | Colourless Odourless Tasteless | Colourless Smells like rotten eggs. Sweet taste. | Colourless Odourless Tasteless | Colourless Acrid taste suffocating odour | Colourless Pungent suffocating odour |
| Physiological Effects | Supports life | Inert | Triggers our breathing | Stops O2 uptake. | Paralyses the respiratory system | Nil | Respiratory irritant | Respiratory irritant |

# Hazardous Gases

There are many different hazardous gases often found in industry such as carbon dioxide, carbon monoxide, methane, sulphur dioxide, hydrogen sulphide, ammonia and chlorine. Other hazards are gases such as butane and propane, LPG and vapours or mists given off by acids, as well as vapours from hydrocarbons such as diesel or petrol.

Acids commonly used in industry include hydrochloric acid (HCl) and sulphuric acid (H2SO4). Even though these are not gases at room temperatures, both acids can produce irritating vapours or mists that can damage the skin, eyes, nose and throat. Severe breathing difficulties may result and signs and symptoms include a choking sensation, coughing and burning of the throat.

Engineering methods to contain these acids using corrosion resistant materials are necessary.

**Hydrochloric Acid (HCl)** has a sharp and irritating odour and is either colourless or light yellow. It gives off an irritating vapour and reacts with water. If it is inhaled, it produces coughing and breathing difficulties. It reacts with metals to release hydrogen which will form an explosive mixture with air in a confined space. It is heavier than air and boils at only 50ºC.

**Sulphuric Acid (H2SO4)** is a liquid that is odourless and colourless to dark brown. However, it produces a violent reaction with water and produces an irritating mist that if inhaled produces coughing and a burning sensation in the nose and throat. It is not flammable but may react with metals to produce hydrogen which will form an explosive mixture with air in a confined space. It is heavier than air.

**Hydrocarbon vapours** are given off liquids such as petrol, diesel and oils. As a hydrocarbon, they are highly flammable and in sufficient concentrations they will explode and burn. As well they are toxic at various concentrations and are heavier than air depending on their chemical composition.

**Ammonia (NH3)** is a colourless gas with a distinctive smell. It is found in many household cleaning products as well as industrial applications such as fertilizers, chemical manufacture, fibres, dyes and explosives. It is often liquefied for industrial use. It is a severe irritant of the lungs, throat and nose and high doses can be fatal. Contact with liquid and gaseous ammonia can cause chemical burns. Ammonia gas is lighter than air and dispersed by winds.

Sewer gases pose the following risks:

**Hydrogen Sulfide**

- Hydrogen sulfide is an explosive and extremely toxic gas that can impair several different systems in the body at once, most notably the nervous system. So potent that it can be smelled at 0.47 parts per billion by half of human adults, the gas will begin to cause eye irritation at 10 parts per million (ppm) and eye damage at 50 ppm. Other low-level symptoms include nervousness, dizziness, nausea, headache and drowsiness. Exposure to higher concentrations can lead to pulmonary oedema and still higher levels (800 to 1,000 ppm) will cause almost immediate loss of consciousness and death.
- Sewer gases can cause asphyxiation via the displacement of oxygen and suffocate occupants. The effects of oxygen deficiency include headache, nausea, dizziness and unconsciousness.
- At very low oxygen concentrations (less than 12%), unconsciousness and death will occur quickly and without warning.
- Oxygen will be at its lowest concentrations in the lowest areas of the sewer or space, which is where heavy sewer gases, principally methane, are likely to collect.
- Methane and hydrogen sulfide are explosive components of sewer gas.
- Vapours from improperly disposed fuel can further increase the risk of fire or explosion.

- Hydrogen sulfide is responsible for sewer gas' characteristic rotten-egg smell, which can be overbearing even at extremely low concentrations. The gas odour is a safeguard, however, because it alerts occupants to the presence of Hydrogen Sulfide long before they're in any serious danger.
- It is important to note that at roughly 100 ppm, the olfactory nerve becomes paralysed, removing the victim's sense of smell and, subsequently, their awareness of the danger.
- Another "warning smell" comes from ammonia, which will sear the nostrils and progressively irritate the mucous membranes and respiratory tract.
- This gas, unlike hydrogen sulfide, is sufficiently irritating that building occupants are likely to vacate before its concentration rises to toxic levels.

# What Are Exposure Standards?

Exposure standards represent the airborne concentration of a particular substance or mixture that must not be exceeded.

There are three types of exposure standard:

a) 8-hour time-weighted average;
b) peak limitation; or
c) short term exposure limit.

Exposure standards are based on the airborne concentrations of individual substances which, according to current knowledge, should not cause adverse health effects nor cause undue discomfort to nearly all workers.

They do not represent a fine dividing line between a healthy and unhealthy work environment. Natural biological variation and the range of individual susceptibilities mean that a small number of people might experience adverse health effects below the exposure standard.

### 8-Hour Time Weighted Average (TWA) Exposure Standard

Eight hour time-weighted average exposure standards are the average airborne concentration of a particular substance that is permitted over an eight-hour working day and a 5 day working week. These are the most common types of exposure standards.

Note: 8-Hour TWA exposure standards may require adjustment where work shifts exceed 8 hours or for greater than a 5 day working week. Refer to Chapter 4 of this Guide.

### Short Term Exposure Limit (STEL)

Short term exposure standards are the time weighted average airborne concentration of a particular substance that is permitted over a 15 minute period. Some substances or mixtures can cause intolerable irritation or other acute effects upon brief exposure, although the primary toxic effects may occur with long term exposure through accumulation of the substance or mixture in the body or through gradual health impairment with repeated exposures.

The short term exposure limit (STEL) provides limits for the control of short term exposure. These are important supplements to the eight-hour TWA exposure standards which are more concerned with the total intake over long periods of time. Generally, STELs are established to minimise the risk of:

- intolerable irritation
- irreversible tissue change
- narcosis to an extent that could precipitate workplace incidents

STELs are recommended where there is evidence either from human or animal studies that adverse health effects can be caused by high short term exposure.

**Peak Limitation**

Peak limitation exposure standards are a maximum or peak airborne concentration of a particular substance determined over the shortest analytically practicable period of time which does not exceed 15 minutes.

For some rapidly acting substances and mixtures the averaging of the airborne concentration over an eight-hour period is not appropriate. These substances may induce acute effects after relatively brief exposure to high concentrations and so the exposure standard for these substances represents a maximum or peak concentration to which workers may be exposed.

**Inhalable Dust**

Inhalable dust refers to the particle size that enters the mouth and nose during normal breathing. These particles may be deposited in the respiratory tract. The term “inhalable dust” applies to both nontoxic and toxic dusts.

Inhalable dusts that are toxic have an exposure standard based upon the substance of concern. Where the toxic component of the dust is measured, this is satisfactory as long as the exposure standard for dusts not otherwise classified is not exceeded. Exposure standards for dusts are measured as inhalable dusts unless there is a notation specifying an alternate method, eg: cotton dust, silica.

Inhalable dusts should be measured according to Australian Standard 3640.

When using gas detection equipment knowing the gases that you are testing for and their exposure limits allows you to make more informed decisions.

Most sites will have a gas chart with the common and identified gases and information relating to them. See appendix at the back of this manual.

| (1) | | (2) | (3) | | (4) | | (5) | (6) | |
|---|---|---|---|---|---|---|---|---|---|
| Chemical name | Synonym | CAS No. | TWA (ppm) | TWA ($mg/m^3$) | STEL (ppm) | STEL ($mg/m^3$) | Carcinogen Category | Notices | Notes |
| Acetaldehyde | | 75-07-0 | 20 | 36 | 50 | 91 | - | - | |
| Acetic acid | | 64-19-7 | 10 | 25 | 15 | 37 | - | - | |
| Acetic anhydride | | 108-24-7 | 5 Peak limitation | 21 Peak limitation | - | - | - | - | |
| Acetone | | 67-64-1 | 500 | 1185 | 1000 | 2375 | - | - | |
| Acetonitrile | | 75-05-8 | 40 | 67 | 60 | 101 | - | Sk | |
| Acetylsalicylic acid | Aspirin | 50-78-2 | - | 5 | - | - | - | - | |
| Acrolein | Acrylaldehyde | 107-02-8 | 0.1 | 0.23 | 0.3 | 0.69 | - | - | |
| Acrylamide | | 79-06-1 | - | 0.03 | - | - | 2 | Sk | |
| Acrylic acid | | 79-10-7 | 2 | 5.9 | - | - | - | Sk | |
| Acrylonitrile | Vinyl cyanide | 107-13-1 | 2 | 4.3 | - | - | 2 | Sk | |
| Aldrin | | 309-00-2 | - | 0.25 | - | - | 3 | Sk | |

http://www.safeworkaustralia.gov.au/sites/SWA/about/Publications/Documents/639/Workplace_Exposure_Standards_for_Airborne_Contaminants.pdf

# SECTION 2

# SELECT AND CALIBRATE EQUIPMENT

Gas sensors need to be calibrated and periodically checked to ensure sensor accuracy and system integrity.

The intervals between calibrations can be different from sensor to sensor. Generally, the manufacturer of the sensor will recommend a time interval between calibrations.

The method and procedure for calibrating the sensors should be established immediately. The calibration procedure should be simple, straightforward and easily executed by regular personnel. Calibration here is simply a safety check, unlike laboratory analysers that require a high degree of accuracy.

For area air quality and safety gas monitors the requirements need to be simple, repeatable, and economical.

Calibration of the gas sensor involves two steps. First the “zero” must be set and then the “span” must be calibrated.

Normal air contains traces of different gases besides nitrogen and oxygen. Also, ambient air normally contains a small percentage of water vapour. Therefore, it is much more realistic and practical to zero the sensor using the air surrounding the sensor when the area is considered to be clean.

This reference point can be difficult to establish. Therefore, a good reference point can be in the area where air is always considered clean, such as in an office area. This will give a more realistic representation of the zero point because it will be representative of the local ambient air condition.

The span calibration can be quite easy or it can be very complicated and expensive, depending on the gas type and concentration range. In principle, to achieve the best accuracy, a mixture of the target gas balanced in the background environmental air is the best calibration gas.

However, although this can be done, it usually requires that the operators be more skilled than would usually be required. In practice, most calibration gases are purchased from commercial suppliers.

Premixed gas mixtures are compressed and stored under pressure in a gas bottle. The bottles are available in many sizes but most field calibrators employ smaller, lightweight bottles. These small portable bottles come in two different categories: a low-pressure and a high-pressure version.

High-pressure bottles are designed to bottle pure hazardous chemicals. For calibration gases, these bottles are normally made of thick-walled aluminium which has a service pressure of 2000 psi.

To get this highly pressurized gas out of the bottle in order to calibrate the sensor, a regulator assembly is needed. This assembly consists of a pressure regulator, a pressure gauge and an orifice flow restrictor.

The orifice flow restrictor is a fitting with a hairline hole that allows a constant air flow at a given pressure difference.

Many gases can be premixed with air and stored under pressure, but some gases can only be mixed in inert gas backgrounds, such as nitrogen. Some mixtures can only be stored in bottles that are specially treated or conditioned. Each type of mixture will have a different amount of time before it expires or before it can no longer be used.

- One way of ensuring quality calibrations are performed is to use a computer based docking system.
- Place the instrument into the docking station and the system is fully automated for both full calibration and bump checking.

Once activated, the system checks the instrument for information:

- last calibrated
- battery condition
- what gases does it detect
- it's specific Identity
- alarm set points

Then it proceeds with a calibration that can be either just recorded or could be produced as a certificate.

# SECTION 3

# HAZARDS AND CONTROLS

## Hazard Identification

It is essential in the first instance that work conditions be examined and hazards identified. Hazards may be classed as:

- Physical
- Chemical
- Ergonomic
- Radiation
- Psychological
- Biological

Hazards may be due to conditions created by:

- Oxygen deficiency - oxidation, dilution by other gases, absorption
- Oxygen excess - leaking oxygen supply,
- Presence of contaminants - dust, fumes, vapours

Presence of ignition sources:

- uncontrolled introduction of solids, liquids or gases
- electrically energised equipment
- extremes of temperature.
- presence of radioactive equipment
- noise
- manual handling requirements
- inadequate lighting
- falls, trips and slips
- obstructions that could prevent swift egress or hinder rescue

## Risk Assessment (JSA / JHA)

A formal risk assessment is to be prepared from which appropriate control measures can be identified and implemented. This will be the basis of the written authority (Entry Permit).

The risk assessment team should include persons with a good knowledge of any work methods which will be used, knowledge of the particular confined space to be entered, familiar with confined space safety practices and proficient in the risk assessment process.

With such knowledge/experience, the team can better consider:

- whether there is a need to enter the confined space.
- the hazards inherent in confined space work and the nature and degree of those hazards,
- individual tasks relating to the work to be done,
- the various methods by which the tasks can be achieved.
- the hazards inherent in performing those tasks and the nature and degree of those hazards,
- emergency response procedures required/available

Further specific factors to be considered include:

- The number of persons occupying the space.
- The number of persons outside to maintain observation and communications, operate essential equipment and initiate emergency procedures.
- Whether the proposed work procedures and operations may cause a change in conditions within the space previous contents of the confined space and atmospheric testing requirements.
- Hazards that cannot be eliminated or may be encountered and the fitness and level of training of those who are to be involved, personal protective equipment and clothing signage, barricades.
- Special instructions required for the area such as no hot work, no naked flames or smoking, no vehicles to be used in the area (exhaust fumes, noise etc.)

With the assessment complete, each risk should now be examined to determine whether it can be eliminated, minimised or at least properly managed.

## Control Measures

Wherever possible, control measures should be put into place to eliminate or minimise and properly manage any risk. The following hierarchy of control measures should be used.

- Elimination, (can the hazard be eliminated?)
- Substitution, (can a less hazardous alternative be used? Eg. less hazardous chemical, lighter weight object etc.)
- Isolation, (can the equipment be de-energised, lockout etc.)
- Engineering controls, (enclosures, guarding, ventilation etc.)
- Administration controls, (job rotation, SOP's, training etc.)
- Use of adequate PPE - Personal protective equipment should only be used either as a last resort when all of the other control measures have failed to adequately control the risk, or in an emergency response.

## Isolation

Isolation requirements are detailed in AS/NZS2865 Sect.10.5 which states:

*Prior to any person entering a confined space, all potentially hazardous services, including all process services, normally connected to that space shall, where it is possible to do so, be isolated in order to prevent –*

*(a) the introduction of any materials, contaminants, agents or conditions harmful to persons occupying the confined space; and*

*(b) the activation or energizing in any way of equipment or services which could pose a risk to the health or safety of persons within the confined space.*

Isolation should be conducted according to local site procedures but should include de-Energisation and lockout, or if lockout is not practicable then tag out, or both lockout and tag out.

Such isolation should be completed by each person entering the confined space or by a competent person authorised in writing by the employer. Specific isolation requirements are identified in the Standard.

# Ventilation

Where it is considered that atmospheric contamination may occur during operations, ventilation operations are used to ensure a safe atmosphere.

The ventilation may be by natural or mechanical means and maintained throughout the period of occupancy

Mechanical ventilation equipment used to maintain a safe atmosphere should be monitored while the confined space is occupied and any controls should be clearly identified and tagged to prevent interference.

# SECTION 4

# USE OF GAS TESTING EQUIPMENT

There are many gas detection units on the market to choose from. Most of the monitors are operated the same way with limited control button to choose from:
They:

- Will prompt for operator input for
- Zero Calibration
- Fault with the machine
- Readings
- Turn on / off by holding specific buttons for a pre-determined length of time

When purchasing monitors for use you must have an understanding of the gases and potential of their strengths. Most monitors now days come with:

- 4 Gas potential
- 6 Gas potential

All monitors must be able to at a minimum test for:

- Oxygen
- Lower Explosive Limit (LEL)

Pictured is a common monitor and the installed sensors as identified by their chemical symbol.

## Properties of Gas Detection Units

- Instruments rely on good battery condition to operate at 100% performance rechargeable batteries work better and last longer when they are allowed to run for their full duration and then fully recharged.
- Poor charging operations are often common, where they are returned to a charger after only a short period of operation this can cause the batteries to fail and deteriorate rapidly.
- Some instruments can be left in the area or worn by workers as a personal gas monitor (PGM).
- Regular maintenance of the parts, sensors and cleaning of units.

## Some of The Limitations of Instruments

- The person using the gas detection equipment may not be competent.
- Humidity and temperature within the space.
- Presence of airborne contaminants such as corrosive gases that
- May reduce the accuracy of the reading or damage the sensor.

## Key Points When Testing

- Test from the outside.
- Attempt to sample before removing covers.
- Remove manholes or covers with caution.
- Stand upwind or clear of venting gas.
- Ventilate for at least 5 minutes.
- Consider using the remote sampling attachment.
- Ensure all levels of the confined space is tested.
- If testing from outside is not possible, then self-contained breathing apparatus must be worn.
- A respirator with filter canister must not be used in a confined space until the Oxygen level can be scientifically confirmed.
- Calibration, adjustment and maintenance requirements.
- Oxygen deficient environments will limit the ability to detect LEL.
- Condensation and/or absorption of gas into the walls of sampling lines where these are used.
- Differences in atmospheric pressure which may cause erroneous readings in some sensors.
- Safe readings of oxygen do not mean safe atmosphere highly toxic gas in minute concentrations may be present.

## Actions for Unsafe Readings

There are three main types of ventilation:

1. Local exhaust ventilation: This type of ventilation uses equipment like exhaust fans, air jet movers (eg: a venturi) and ducting. It allows the contaminant to be removed at its source or at a collection point, for example a high point in the top of a confined space where lighter than air gases may accumulate.

2. Dilution ventilation: This type of ventilation uses fans and or air hoses. It is not as efficient as local exhaust ventilation because the contaminants are diffused throughout the enclosure. It is however a common means of ventilating a confined space especially before a gas test is performed.

The first two types of ventilation are often referred to as mechanical ventilation.

The last main type of ventilation is:

3. Natural ventilation: In many cases a confined space can be ventilated by opening hatches, doors, vents, etc. and allowing the wind or air currents to ventilate the confined space. This type of ventilation is often used when there are no real or serious atmospheric hazards in the confined space.

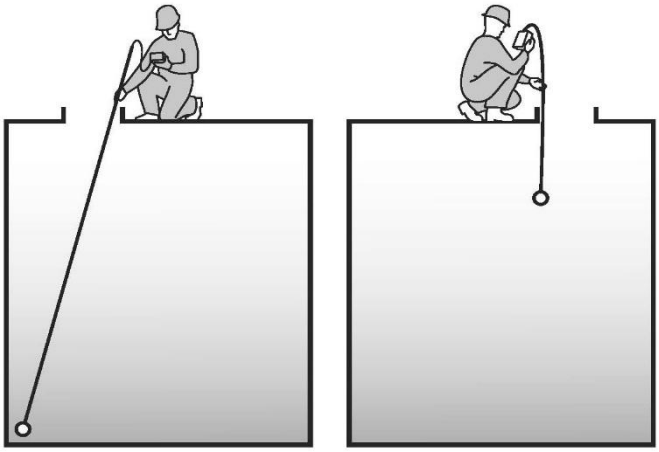
If you have not purged the confined space and there is a need to do a gas test, then you will be required to ventilate the enclosure. Choose whatever form of ventilation best suits the hazards in

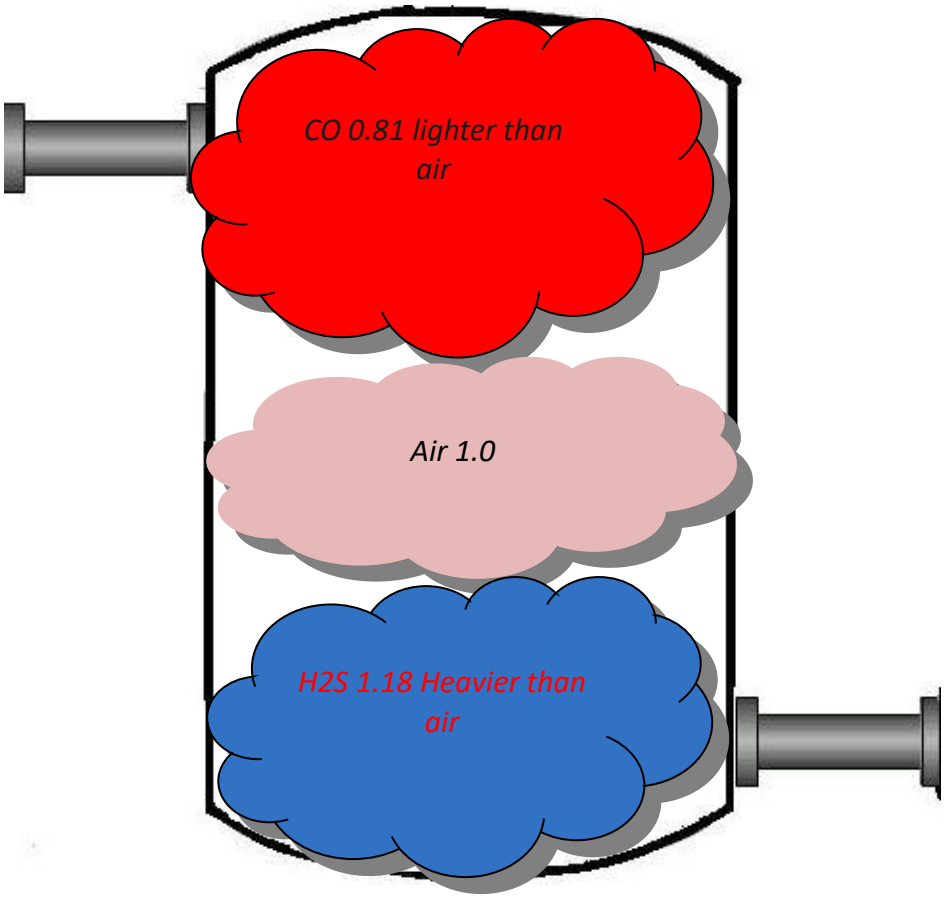
the confined space, for example, if the atmosphere is hot and humid, then use a fan to cool the inside of the confined space and lower the humidity.

## Layering of Gases

Initial testing should be done from outside the confined space by inserting a sample probe and/or portable gas detection device at appropriately selected access holes, nozzles and openings. Because contaminants can settle at different levels, each part of the confined space should be tested – side to side and top to bottom (see Figure 2).

For example, some gases (such as hydrogen sulfide) are heavier than air and in unventilated areas will settle to the bottom of the space, while other gases (such as methane) are lighter than air and will collect at the top of the space. Testing should be carried out on a sufficient number of points to accurately reflect areas of the space that is likely to be accessed.






- Maximum sampling distance 100ft. with 3/8 Polyurethane tubing.
- 2 by 2 sampling rule:
  - 2 seconds per foot of tubing (minimum requirement).
  - 2 minutes sample time (sensor response).
- Confined Space sampling.
- Top, Middle, Bottom (at a minimum, 4 ft. intervals).

Sensors need at least 2 minutes to react to the gases in a normal industrial setting. Take your time and do not be rushed.

Many gas detection units today have tubing attached and some even have telescopic wands which can extend 6-7 feet in length. The pumps are small and pulling atmosphere through a 3/8 plastic tube takes a while. Give the machine time to test the air properly and ensure it is truly safe.

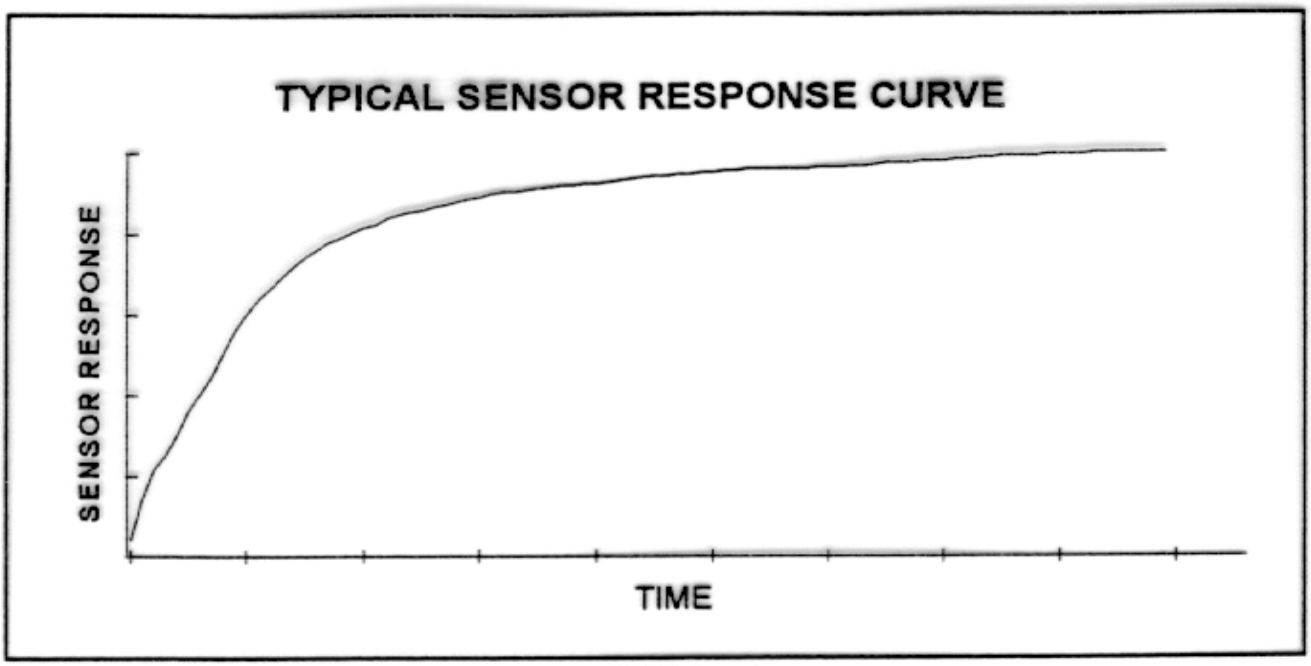



FIGURE 1

# SECTION 5

# LOOKING AFTER YOUR GAS DETECTION UNIT

## Poor Gas Testing Practices

- Immersing the probe or gas detector into liquid, will damage or contaminate the cell.
- Dropping and knocking the gas detector.
- Using for prolonged periods in high gas concentrations, as this will damage or burn out the detector.
- Using raw mixtures, eg: car exhausts, cigarettes, vapours from fuel tanks, acetylene.
- Forcing the mixture through the gas detector.

If the probe, tubing or the sensors come into contact with contaminates then the machine needs to be pulled apart and cleaned thoroughly. Most detection units supply filters to be placed in between the tubing and the unit pump.

Filters should be utilised when available as they are a very cheap insurance policy for your gas detection equipment.

Without the filters the machines can be exposed to a lot of contamination especially in an industrial setting.

As many sites utilise automatic docking stations, and as such they need to be placed in a stationary position with:

- Easy access
- Regular attention
- Clean and dust free environment

With this situation all detectors are usually returned to this one position within the site or job area. Sites will dictate where these units are to be returned to and their internal procedures will reflect this.