Gas Test Atmospheres

This training manual is based on the National Units of Competency:

MSAPMOHS217A Gas test atmospheres

Training Course Overview

You will learn about:

- **Prepare for gas testing**
- **Using a gas monitor**
- **Reading a gas monitor**
- **Maintaining your gas testing equipment**

Gas Test Atmospheres Course Content

Introduction
Theory of breathing
Atmospheric hazards
Gas and vapours
Common gases to be tested for
Choosing your gas detection equipment
Gas detection tubes
Gas testing procedures
Exposure standards for toxic gas
Fire & explosion
Oxygen
Ensuring accuracy of your monitor
Compliance

Module 1

1.1 Gas test atmospheres

1.1.1 Introduction

This module is designed to make you a competent person to gas test atmospheres.

Without doubt the biggest hazard in a confined space is gas, and gas cannot be detected unless you are CORRECTLY using a suitable gas monitor.

This module will cover:

- Theory of breathing & the effects of respiratory hazards
- How to measure gases and vapours
- How to correctly use gas detection devices

Which will enable you to:

1. **Prepare for gas testing**
   - determine type of gas/atmosphere to be tested
   - Select and calibrate equipment in accordance with company procedures & bump test of required.
   - Determine gas testing regime
   - Identify hazards from possible atmoshere contaminats
   - Implement hazard control measures, including use of approprite personal protective equipment PPE.

2. Test for gas
   - Use the gas testing equipment to test for gas
   - Interpret and report readings
   - Monitor gas on an ongoing basis as required
   - take required actions if readings are unacceptable

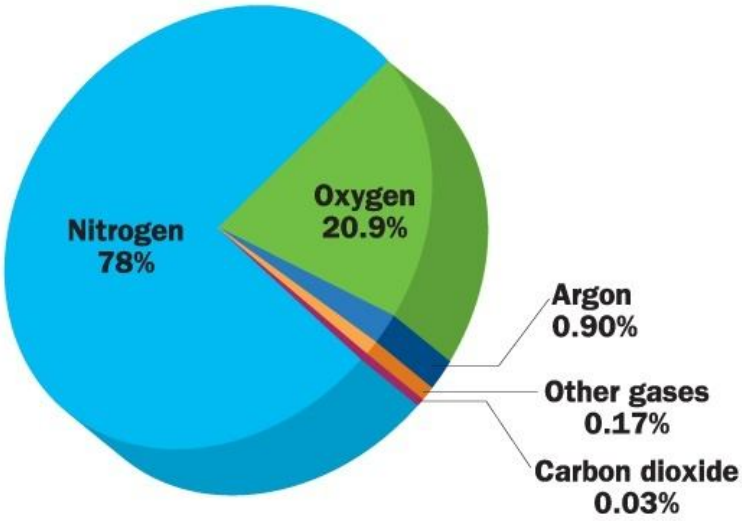
3. Maintain your gas testing equipment in accordance with procedures:
   - Clean & maintain gas testing equipment
   - Inspect and fault find monitoring equipment
   - Return gas testing to required location & in required condition
   - Maintain records of tests and results

Upon successful completion of this programme you will receive a certificate of attainment for the national unit of competency **MSAPMOHS217A Gas test atmospheres**

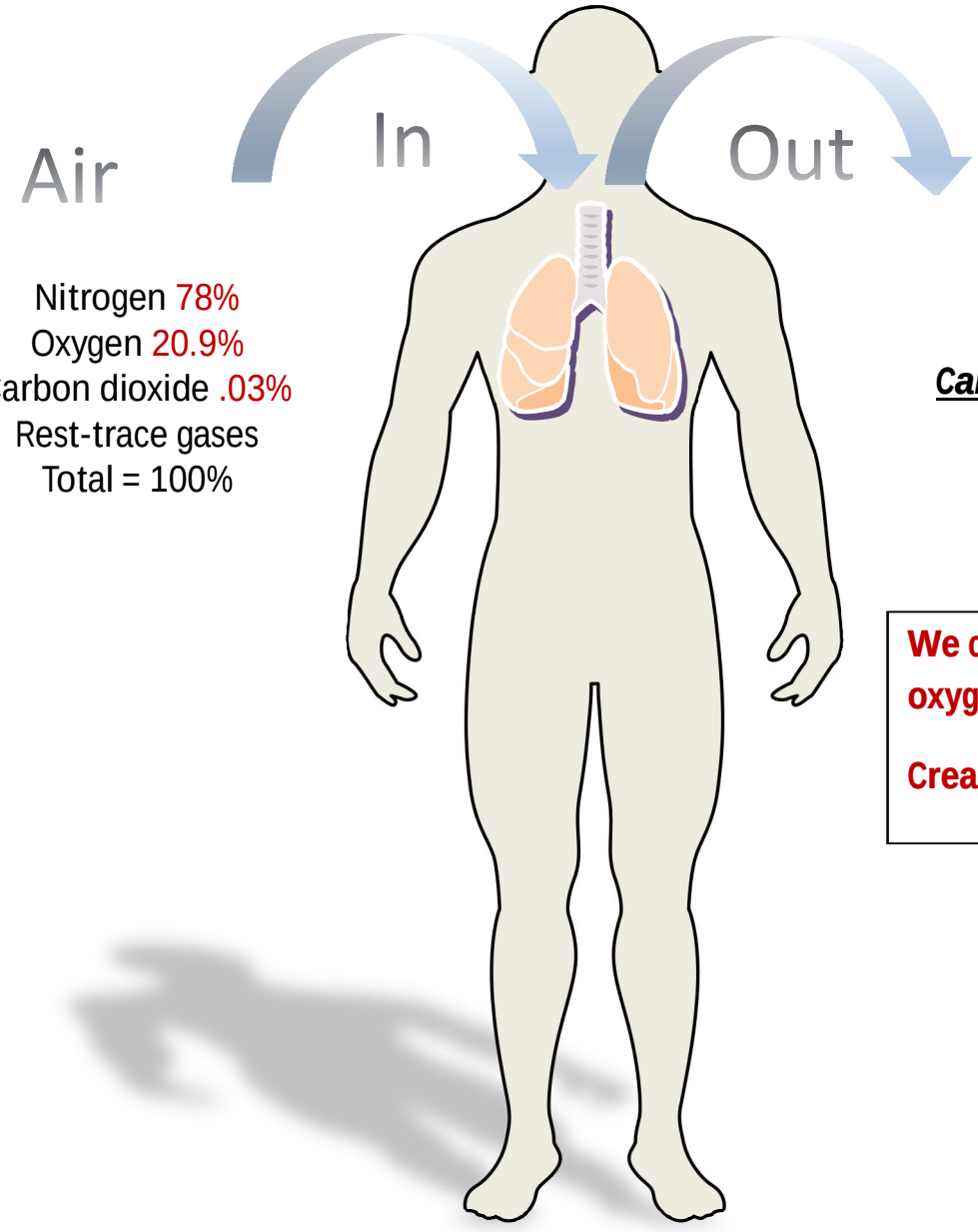
1.1.2 Theory of Breathing

Air is made up from a mixture of gases.

- Nitrogen 78.085%
- Oxygen 20.946%
- Carbon Dioxide 00.033%
- Trace Gases 00.997%



The act of respiration.



Nitrogen 78%
Oxygen 20.9%
Carbon dioxide .03%
Rest-trace gases
Total = 100%

Nitrogen 78%
Oxygen approx. 17%
Carbon dioxide approx. 4%
Rest-trace gases
Total = 100%

We consume approx. 4% oxygen &

Create 4% carbon dioxide

Carbon dioxdie CO2 is a waste gas and needs to be expelled from the body. We call carbon dioxide and a stimulus gas, it stimulates us to breathe.

1.1.3 Atmospheric Hazards

The atmosphere has many respiratory hazards which can include:

Dust – small solid particles of material floating in the air that can be harmful

Fumes – small solid particles generally created from heated metal operations such as welding or soldering. This material can be very harmful to the lungs

Mists – suspension of fine drops of liquid in a gas, what is the source of the mist?

Gases - an air-like fluid substance which expands freely to fill any space available, irrespective of its quantity. Can be harmful

Vapours - a substance diffused or suspended in the air, especially one normally liquid or solid. I.e. solvent vapours

Mists, fumes, vapours and gases all can be taken into th respiratory system and if breathed at high enough concentrations can be harmful to the body.

1.1.4 Gases and vapours

We classify gases and vapours into three categories

1. **Toxic gases & vapours**
2. **Flammable gases & vapours**
3. **Oxygen excess or deficiency**

Toxic gases & vapours are considered poisonous gases such as Hydrogen Sulphide (H2S), Carbon Monoxide (CO), but could also be other gases such as chlorine, ammonia, sulphur dioxode, nitrogen dioxide, cyanide or phosphine.

Flammable gases & vapours (Hydrocarbons) are those when exposed to an ignition source might explode. The common flammable gases are considered to be methane (CH4) & propane (C3H8) but also include butane, hydrogen, acetylene and hexane.

Oxygen excess or deficiency can cause either death or increase the risk of fire & explosion.

IT IS THEREFORE IMPORTANT THAT WHEN RISK ASSESSING FOR GASES AND VAPOURS, YOU IDENTIFY WHAT EXACT GASES AND VAPOURS MAY EXIST IN THE WORK PLACE, AND OBTAIN THE CORRECT GAS MONITOR TO IDENTIFY THOSE HAZARDS. You may need to consult engineers, plant operators or safety officers on site.

VOCs are volatile organic compounds emitted as gases from certain solids or liquids. VOCs include a variety of chemicals, some of which may have short- and long-term adverse health effects. Concentrations of many VOCs are consistently higher indoors (up to ten times higher)

than outdoors. VOCs are emitted by a wide array of products numbering in the thousands. Examples include: paints and lacquers, paint strippers, cleaning supplies, pesticides, building materials and furnishings, office equipment such as copiers and printers, correction fluids and carbonless copy paper, graphics and craft materials including glues and adhesives, permanent markers, and photographic solutions. VOCs are measured in parts per billion and a normal 4 gas monitor will not detect them. To detect VOCs you need to use a VOC gas monitor.

1.1.5 Common gases to be tested for

A standard 4 gas monitor will detect:

1. Carbon Monoxide (CO) – created by incomplete combustion (toxic)
2. Hydrogen Sulphide (H2S) – created by breaking down of organic matter (toxic)
3. Methane (CH4) – created by breaking down of organic matter (explosive)
4. Oxygen (O2) – leakage (too much) or deficiency due to displacement by another gas, rust, chemical reaction (too little)

Make sure the gas monitor you use is looking for the gases identified by your risk assessment.

1.1.6 Choosing your gas detection equipment

A based on your risk assessment the following gas detection equipment is available:

1. **Compliance** – this is a standard four gas monitor as discussed above and are what are commonly advertised in the market place
2. **Customised** – as a result of your risk assessment, the compliance monitor will not detect the gases you are looking for. If there is another gas present plus the standard four gases, you can either purchase an additional single gas monitor, or you may wish to purchase a five gas monitor which includes your additional gas. Or you may need to have the flammable sensor calibrated for a flammable gas other than methane, some selected monitors have this feature built in.
3. **Diffusion** – most gas monitors work on diffusion, the gas passes through a filter membrane and comes into contact with the sensor to provide a reading.
4. **Sample draw** – is where your monitor has either an internal or external pump which draws the gas through a tube. You need to know what is the maximum draw depth of the monitor you wish to use ie 5m, 10m, 15m etc

1.1.7 Gas testing procedures

Operating a gas monitor.

- **Inspect the gas monitor for damage & ensure it is within calibration**
- **Ensure you are in FRESH AIR, then turn it on**
  - monitor that it does an automactic fresh air calibration (ZERO)
- **If it does not do an automatic ZERO, conduct a manual ZERO**
- **Ensure it is accurate by carrying out a BUMP CHECK using certified gas**
- Check power levels/battery
- Know how to "Recall" the PEAKS or data
- Know how to "Clear" the PEAKS or data
- Know how to TURN OFF

1.1.8 Exposure Standards for toxic gas

Exposure standard means an airborne concentration of a particular substance in the worker's breathing zone, exposure to which, according to current knowledge, should not cause adverse health effects nor cause undue discomfort to nearly all workers.
The exposure standards for toxic gas are:

- **time-weighted average (TWA),**
- **short term exposure limit (STEL) or**
- **ceiling (C)**

Time-weighted average (TWA) means the average airborne concentration of a particular substance when calculated over a normal eight-hour working day, for a five-day working week (40 hours)

Short term exposure limit (STEL) means a 15 minute which can occur only four times a day, provided there is a 60 minute break between exposures. You cannot exceed youir daily TWA at any time during a working day.

Ceiling - this exposure cannot be exceeded at any time.

PEAK means a maximum or peak airborne concentration of a particular substance.

Toxic Gases are measured in PARTS PER MILLION, which is the best measurement scale to detect the gas prior to it becoming a problem.

Your gas monitor will monitor your TWA & STELs throughout your work activity. Do not turn your monitor OFF during the day, as this will affect the TWA & STEL readings. This is important if you are moving from one confined space job to another on the same day.

1.1.10 Fire & Explosion

A fire or explosion requires the presence of three elements: an ignition source, air and a fuel (gas, vapour or mist) capable of igniting. A flammable atmosphere is one in which the flammable gas, vapour or mist is likely to exceed its lower explosive limit (LEL).

Flammable atmospheres in confined spaces may result from the evaporation of a flammable residue, flammable materials used in the space, a chemical reaction (such as the formation of methane in sewers), or from the presence of combustible dust (such as that in flour silos).

If an ignition source, such as a sparking electrical tool or static on a person, is introduced into a space containing a flammable atmosphere, an explosion is likely to result.

The gases that we are concerned with are flammable with combined with oxygen in air.

There is about 21% of oxygen in air.

Lower explosive limit. The Concentration of flammable gas or vapor in air below which the gas is not explosive.

Upper explosive limit. The concentration of flammable gas or vapor in air above which the gas is not explosive.

Range
Methane – 5% to 15%
Propane -1.5% to 9%

1.1.11 Oxygen

Remember in AIR there is 20.9% oxygen. Gas monitors read exactly what oxygen concentration there is in the atmosphere.

Your oxygen sensor alarms when it detects either too much oxygen or not enough.

Too much = 23.5% (warning of the increased risk of fire or explosion)

Not enough = 19.5% (warning of potential asphyxiation)

REMEMBER- If your oxygen level has dropped or risen, there must be a reason why??? So although alarms are set at 23.5% high or 19.5% low, if your monitor moves away from 20.9% you need to know why!!!!!!!

Where there is a loss of oxygen showing on your monitor, **REMEMBER that the monitor is only measuring the oxygen content of the air**, and not the **nitrogen content**. You need to add back the loss of nitrogen (N2) and in simple terms air is a mixture of 20% 02 to 80% N2, which is the same as a 4:1 mix.

Monitor reads 19.9% should read 20.9% no alarm.

If another gas has entered the space, it has displaced air so therefore:

O2 loss = 1% as shown by monitor = 10,000ppm

N2 loss = 4% as that is the balance in air = 40,000ppm

TOTAL loss in the space is 5% = 50,000ppm of another gas???

1.1.12 Ensuring ACCURACY of your monitor

To ensure the sensors in your monitor are working correctly you:

1. **Conduct a ZERO** in fresh air each and everytime you turn you monitor on.

2. **Carry out a BUMP test**. After turning your monitor on and conducting a ZERO, you now connect a bottle of certified calibration gas to your monitor using the calibration cup supplied with the monitor, turn the gas ON and allow it to pass over the sensors until they all PEAK (stabalize at the heighest level). Ignore the alarms and check your monitor gas readings against the levels shown on the bottle. You are allowed a variation of +/- 5% of the shown reading. This is also called an ACCURACY CHECK, A CHALLENGE or a RESPONSE CHECK. It is not mandatory, but recommended by all gas monitor manufacturs.

3. **Ensure your monitor is CALIBRATED every SIX MONTHS**. The monitor will indicate to you when calibration is due. You can either purchase the calibration equipment, or send it to a certified gas calibration organisation like Sydney Safety Training.

1.1.13 Compliance

Please ensure:

1. Your personnel gas testing are COMPETENT
2. Your monitor is testing for the gases identified in your Risk Assessment
3. The monitor is ALWAYS turned on in FRESH AIR & ZEROED
4. When the PEAKS are read, the readings are ALWAYS recorded in your Confined Space Permit, and then CLEARED
5. Your gas monitors are CALIBRATED at six monthly intervals and the calibration certificate is filed
6. At the end of each working day the monitors are CHARGED

5 Gas

4 Gas