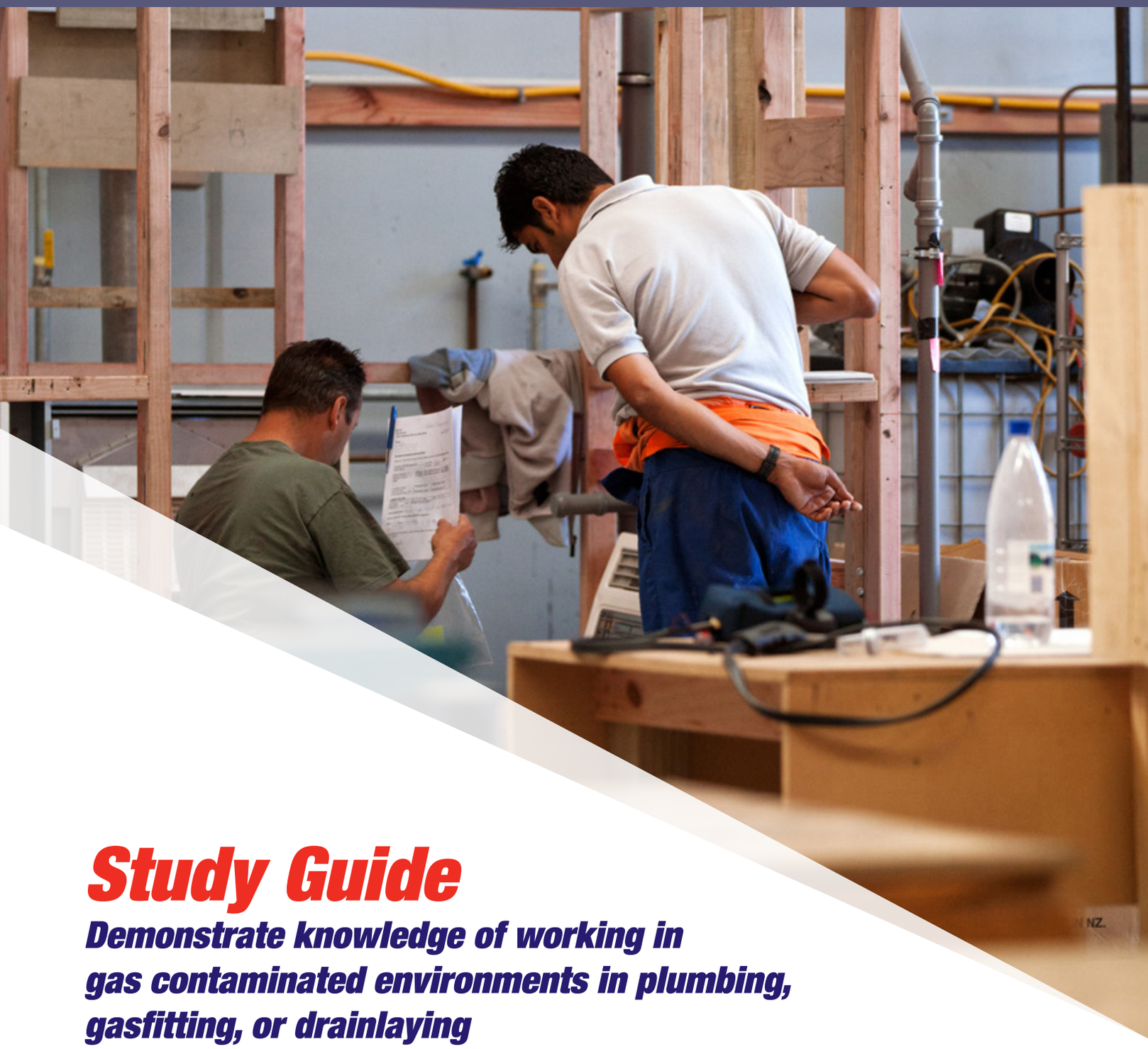


Study Guide

Demonstrate knowledge of working in gas contaminated environments in plumbing, gasfitting, or drainlaying

21883 | Version 3 | Level 2 | Credits 3

Trainee Name _____

Grow by growing others

skills.

Unit Standard 21883

People credited with this unit standard are able to:

- demonstrate knowledge of the properties and hazards of gas types for gasfitting
- describe the precautions and actions to be taken when working with different gas types for gasfitting

The best way to use this Study Guide is:

1. Read through the following information step by step.
2. Where other resources are mentioned (such as websites), find those and read them as well.
3. Complete the practice exercises. There are **no answers** to practice exercises in this Study Guide. Show your answers to your supervisor or tutor so they can check and discuss them with you and give feedback.

Contents

Properties of gas

This section is about the different properties of gases and why they can be dangerous to work with.

Gas is one of the three states of matter, the other two states being liquid and solid. Drainlayers and plumbers usually deal with liquid, and gasfitters usually deal with gas.

However, all three trades will come across gas at some stage and must be aware of the hazards of gas. There are different types of gas and each has different properties and dangers, for example, pure oxygen will burn fiercely or even explode if ignited. Many common, dangerous gases have no smell.

The main properties of gases include composition, visibility, flammability, concentration toxicity, density relative to air, smell, ignition, temperature and burning. We will also look at four dangers of working where gas is present.

Composition

The gases plumbers, gasfitters, and drainlayers can be exposed to are often a mixture of different elements. This table shows what the common gases are composed (made up) of:

Properties	LPG	Natural gas	Methane	Carbon monoxide	Oxy-acetylene	Carbon dioxide	Hydrogen sulphide
Composition	60% Propane 40% Butane	Mostly Methane	1 Carbon and 4 Hydrogen	1 Carbon and 1 Oxygen	2 Carbon and 2 Hydrogen	1 Carbon and 2 Oxygen	2 Hydrogen and 1 sulphur
Visibility	No	No	No	No	No	No	No
Flammability	Yes	Yes	Yes	Yes	Yes	No	Yes
Concentration (g/mol)	44.097	16.04	16.04	28.010	26.04	44.01	34.1
Toxicity	No	No	No	Yes	No	No	Yes
Relative density to air	Heavier	Lighter	Lighter	Similar	Similar	Slightly heavier	Heavier
Noticeable smell	Yes	Yes	No	No	No	No	Yes
Ignition temperature	470 °C	580 °C	580 °C	609 °C	300 °C	N/A	270 °C
Burning temperature	1967 ºC	1960 °C	1950 °C	2121 °C	3200 °C	2468 °C	2800 °C

Composition properties of some common gases

Visibility

You cannot see most gases and so will not be aware they are there. Because gases are invisible, being able to smell them is very important.

We cannot see them because the atmosphere scatters most of the colour, spreading the colours' wavelength until it becomes too long to be seen by the human eye.

Smell

Your sense of smell can warn you of the presence of gases, if the gas does have a smell.

Natural Gas and LPG have no natural smell. An odour is put into them during manufacturing, so you can detect leaks by smell.

Methane gas and carbon monoxide also have no smell.

Hydrogen sulphide smells like rotten eggs at low concentrations. However, at higher concentrations (and with a greater risk of explosion) the smell of hydrogen sulphide lessens. Therefore, even a faint smell should be reported and acted on.

Sewer gas is a mixture of various gases and has an unpleasant smell. Drain and sewer gases may include methane and hydrogen sulphide, ammonia, carbon dioxide, sulphur dioxide and nitrogen oxides.

Because sewer gas contains methane, it is flammable. However, the methane in it has no smell. (Remember that Natural Gas is mostly methane).

Ground gases from decomposing rubbish in landfills (rubbish tips) contain flammable gases. Sometimes extraction fans are used to draw out these gases and burn them in gas engines to generate electricity. Ground gases may include Natural Gas (methane), carbon dioxide and hydrogen sulphide (common in thermal regions).

Density

Gases have different densities. This means that some will rise up (those lighter than air), while others fall (those heavier than air). LPG is the best example of a gas that is heavier than air.

Concentration

Concentration of gas is the amount of a gas type in a given volume of air. If there is a lot of gas in a confined area, the gas is said to have a high concentration, which can be dangerous.

For example, a high concentration of CO^2 (carbon dioxide) can replace air in a confined space, to the point where there is not enough oxygen to allow a person to breathe. CO^2 is also slightly heavier than air and can gather in low areas creating a confined space hazard.

Toxicity

Toxicity is a measure of how poisonous a gas is. Low concentrations of toxic (poisonous) gas in the air can make a person ill. Slightly higher concentrations of toxic gas in the air can easily kill.

The main toxic gas is carbon monoxide (CO), which is in the exhaust gas of petrol engines. It is particularly dangerous to use these engines while in confined spaces. It is also present through incomplete combustion of gas burning appliances.

- non-toxic gases won't poison a body, but they can starve the body of oxygen
- low concentration levels of non-toxic gases in air make a person drowsy
- medium levels of non-toxic gases make people sleep while high levels can asphyxiate and kill

Flammability

Flammability is the ability to burn. The terms flammable and combustible mean the same thing and are often interchanged. Flammable things can be burned, and combustible things are easy to ignite.

Only three things are needed to achieve combustion: air, fuel and ignition.

If a gas is flammable or combustible that means it will burn in the presence of air when ignited. A flame or a spark can ignite any flammable gases in the air causing a fire or an explosion. The air to gas ration is called the 'flammability range'. Gases have different flammability ranges depending on their gas type and composition.

Some gases do not burn. Carbon dioxide, for example, does not burn and does not support combustion. This is known as an inert gas.

Ignition temperature is the temperature at which a flammable gas, when mixed with air, will burn or explode if ignited. Gases ignite at different temperatures, so each gas has its own ignition temperature. Anything that reaches or exceeds ignition temperature is a possible source of ignition.

Note: *A Royal Commission considered possible ignition sources for the Pike River gas explosion, which caused the deaths of 29 miners in 2010. Those ignition sources included: electrical arcing from pumps being switched on, cigarettes, matches, lighters, cell phones, watches, cameras, aluminium cans and food wrappers.*

Ignition sources start fires or explosions by creating sparks, flames or hot surfaces.

Cigarettes, electrical equipment (including power tools), static electricity, electric cables, vehicles and machinery are all ignition sources.

Sparks

Sparks can be generated by:

- two stones hitting each other (this is where the name 'flint stones' comes from)
- dropping a metal tool or object onto concrete or metal
- flint wheels on liquid fuel cigarette lighters
- mobile phones and two-way radios

- electrical appliances and motors for power tools and equipment
- Hand tools such as battery powered torches unless they are intrinsically safe
- piezo igniters on gas filled cigarette lighters or barbeque lighters
- piezo igniters on gas appliances
- electronic spark igniters on gas, oil burning, battery, or mains operated appliances

Flame

Flames may come from:

- gas or oil burners
- solid fuel fires
- permanent pilot flames on gas or oil burning appliances
- accidental fires of buildings or materials.

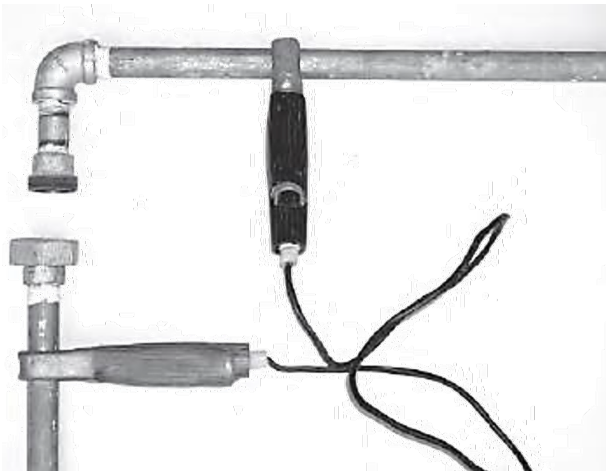
Hot surfaces

You should regard anything hot enough to glow as a source of ignition.

Examples of hot surfaces include:

- glowing embers left over from a fire (or even a glowing cigarette)
- hot exhaust pipes and manifolds from engines
- hot materials such as ceramics or fire bricks used in boilers, furnaces and heating appliances
- electric heating or ignition elements
- elements in lamps or torches.

The risk of ignition/explosion can be minimised by keeping sources of ignition away from the work area. For example, tradespeople should use a bonding strap to bridge any metal pipes before disconnecting or cutting metal pipes. A bonding strap is a heavy-duty wire which clamps to metal pipes either side of the proposed cut or disconnection. If any stray electric current is passing through the pipes it will pass through the bonding strap, which acts as a bridge for the current.



A bonding strap being used to bridge metal gas pipes

Gas as a hazard

The presence of some gases can be a hazard to your health. Plumbers, gasfitters and drainlayers can be affected by gas when they are working in trenches, pipes or culverts. They can be exposed to gas from gas services, drains and sewers or ground gases. Many common dangerous gases have no smell.

Gas from services supplied through pipes are either fuel gases (Natural Gas or LPG) or other compressed gases, for example compressed air. Drain and sewer gases may include methane and hydrogen sulphide, ammonia, carbon dioxide, sulphur dioxide and nitrogen oxides. Ground gases can include Natural Gas (methane), carbon dioxide and hydrogen sulphide (which is common in the thermal regions of New Zealand).

Solvent fumes come off adhesives, sealants and solvents used with plastic pipes. Indoor areas must be ventilated when using solvent-based products.

Welding fumes are hazardous. Plenty of ventilation must be used where welding takes place. Note that welding galvanised steel produces fumes that are both corrosive and toxic.

Any vehicle or motor driven equipment that runs on petrol or diesel produces exhaust fumes, which are a mixture of gases containing carbon monoxide (CO) and are toxic.

Machinery operators must ensure that the exhaust outlet discharges (vents) safely to outdoors.

Working where gas is present

Excavations take place in different types of ground. The situations where drainlayers are most likely to be exposed to dangerous gases are:

- peaty ground
- reclaimed ground
- city streets
- petroleum installations

There are four dangers when working where gas is present:

1. asphyxiation (suffocation)
2. toxicity (poisoning)
3. flammability (potential fire)
4. explosion

Asphyxiation (suffocation) happens when your body is starved of oxygen. About 20% of the air you breathe is oxygen. You cannot live without it. If the level of oxygen in the air drops just a little (below 19%) dizziness, then unconsciousness can occur within a minute. If oxygen is not quickly restored, asphyxiation and death soon follow.

Poisoning would occur if the gas breathed in is toxic (poisonous). The body is then at risk of being poisoned before suffocation happens.

In the event of exposure to toxic gases from a contaminated area, the persons affected should be safely removed to an area of fresh air, first aid should be administered as required, and medical assistance sought.

Activity 1

1. Can you always see gases? Circle Yes/No

2. Can you always smell gases? Circle Yes/No

3. Name a common toxic gas.

4. List **five** flammable gases from the table *'Composition properties of some common gases*.'

5. Give **three** gases listed in the table that could asphyxiate you.

6. Name **three** dangers of working in the presence of gas.

Check your answers with your tutor or supervisor.

Working with different gas types

This section is about the precautions that should be taken to prevent fire and to protect people. It is also about what action should be taken if a fire breaks out or a person is exposed to toxic gases.

Precautions and actions to be taken

Precautions working in the proximity of fuel gas

Fuel gas is flammable and includes Natural Gas and LPG. If working on a site with a fuel gas, any suspicious gas smell or leak should be reported immediately to your supervisor. They will be aware of possible dangers and will advise you on a safe course of action.

Keep your workplace well ventilated so there is no accumulation of a flammable or explosive gas/air mixture. There should be a safe oxygen level present.

Make sure you are fully trained in the use of personal protective equipment (PPE) before using it. In a gas hazard situation this includes how to use gas leak detectors.

Make sure hazards are managed in accordance with the Health and Safety at Work Act 2015 (HSWA) requirements. This Act has requirements for a hazard identification system, such as signage, to warn against ignition sources near gas systems.

Minimise the risk of ignition/explosion by keeping sources of ignition away from the work area. This includes the use of a bonding strap to bridge any metal gas pipes before disconnecting or cutting.

Turn off a controllable gas supply before working

It is too risky to work on pipes with ‘live’ gas flowing through them. ‘Live’ gas is gas that is under pressure and continues to flow. Your work would allow uncontrolled gas to escape and could create a flammable or explosive gas/air mixture or cause asphyxiation.

There will be ‘residual’ gas left in pipework, which can be smelt once pipework is cut.

Whenever you can turn a piped gas supply off, you should do so before carrying out any work that may be affected by the gas. All mains should be isolated or turned off before starting work. Residential gas users will have a shut-off valve at the inlet to the gas meter, or an isolation valve on LPG cylinders. The meter should also be capped at the outlet before copper brazing is done on internal pipework.

> ***Note:*** *If you have accidentally damaged a gas pipe after the gas supply point, you should isolate the supply at the meter or cylinder’s isolating valve, and have a gasfitter make repairs and re-test for soundness.*

If the leak is before the gas supply point, **this is not classed as gasfitting work** and you won't be able to turn off the gas supply.

You should then:

- cordon off the area
- keep ignition sources well clear
- call the gas supply company to repair and retest for soundness.
- contact emergency services
- ensure the customer is informed

Ventilate in case of ground sewer gases or fumes

Always make sure there is plenty of fresh air flow into and out of your workspace. The ventilation will introduce fresh air and both dilute and carry away contaminant gases that may be toxic or flammable.

Even if you are working outdoors, for example in an open trench, you could accidently fracture a gas pipe, or it could already be leaking. If it is Natural Gas it will rise and tend to smother you. LPG will accumulate in the trench and spill over the ground like water.

Working with live gas

If your employer sub-contracts to the gas supplier to do this kind of work, then you would first need to be trained to:

- use breathing apparatus
- have another person just outside of the gas affected area who is standing by observing you and is ready to assist if necessary
- wear boots with no metal fittings or attachments
- exercise care in handling and using hand tools so as not to create sparks

Eliminating sources of ignition

You should always keep any source of ignition well away from a potentially flammable air/gas mixture.

Remember:

- adequate ventilation will help to dilute flammable gases and may prevent a flammable air/gas mixture from forming. It can also dilute and remove toxic and non-toxic gases
- turn off liquid or gas burning appliances or equipment by the isolation valve, if it is safe to do so
- do not operate electrical machinery as motors create sparks
- do not operate light or power switches as they arc (spark) when you do, even if you turn them off
- do not smoke!
- wear cotton clothing to avoid static electrical discharge (a spark)
- wear footwear without metal fasteners or attachments
- remember motor vehicles or mortised equipment create hot surfaces, so keep them a safe distance away
- take care when handling and using hand tools, which could create sparks when used or dropped
- do not run electrical cables through or touch any exposed cable terminals in a gas affected area
- do not connect/disconnect live cables – turn power cables off before connecting and disconnecting

In a potentially flammable gas affected area, you must not use:

- power tools
- cell phones or two-way radios
- electric lamps or torches that are not specially made safe (cannot ignite surrounding gas)
- flame or arc welding equipment

Activity 2

1. What is the first precaution you should take if toxic or flammable gases may be present?

2. List the **three** types of ignition sources.

3. List **five** ways a spark may be created.

Check your answers with your tutor or supervisor.

Actions to take in the event of a gas fire

Natural gas and LPG gas appliances are designed to burn gas safely. If you find that either of these gases, or any other flammable gas is burning out of control (not in an appliance) then you must decide quickly what to do about it. The burning gas will soon set fire to any other flammable materials such as timber and fabric such as polyester clothing.

Firefighting requires special training. If you are already a volunteer firefighter, then you are trained in what to do in the event of a fire. If you are not a trained firefighter, you should be aware of the actions you will need to take in case of an emergency. Your first concern must be for your own safety and the safety of others. You must also call (or have someone else call) the Fire Service.

If a gas fire starts:

- report the fire immediately to your supervisor
- keep yourself safe from harm
- help to isolate the scene by turning off the gas main as directed by your supervisor
- keep all people present at a safe distance away from the fire.

Dealing with a controllable gas supply

Providing you can do safely without risking harm to yourself, you should turn off the flammable gas supply. Deprived of its fuel, the gas fire will go out. However, residual fire of any flammable materials may continue to burn.

Dealing with an uncontrollable gas supply

If the burning gas is ground or sewer gas, or any other uncontrolled flammable gas supply, then you won’t be able to turn it off. Evacuate the building or area and cordon it off. Keep watch from a safe distance until the Fire Service arrives.

Extinguishing a gas fire

You must decide whether you can attempt to put out a fire without putting yourself or others at risk. If you can’t turn off the gas supply, you have little chance of putting out a gas fire. Any accumulating unburnt gas is potentially explosive, and your best chance is to evacuate the area immediately.

An LPG fire is potentially a lot more dangerous than a Natural Gas fire because of the amount of stored energy in the LPG bottle or reticulated main.

A dry powder extinguisher is the best option for putting out flammable gases. Remember that you should only use an extinguisher if it's safe to do so considering the size and location of the fire (your extinguisher will only last 10-15 seconds once started). You have more chance of putting out flammable materials that the burning gas has set alight, but it depends on how large the actual fire is.

Check out the fire and emergency New Zealand site for more information.

Don’t let a gas fire start!

Remember: Ventilation, toxicity, flammability, ignition sources.

Carbon monoxide poisoning

Carbon monoxide is poisonous. Exposure to any toxic gas is life threatening. For any toxic gas, you must immediately ventilate the area to ensure your own safety and then remove the affected person to fresh air, monitor their condition, and call for medical aid. Inform the medic which toxic gas has been present if you know what it is. Let us consider carbon monoxide poisoning as an example.

The symptoms of carbon monoxide poisoning include:

- drowsiness
- nausea
- false sense of well being
- disorientation
- impaired judgment
- change in facial skin colour

A conscious person affected by carbon monoxide would display some or all of the above symptoms.

Carbon monoxide poisoning has both short and long-term effects. Short-term effects include headaches, nausea, vomiting, drowsiness, and poor coordination. Some of those effects, particularly drowsiness, can make a person unable to get him or herself away from the toxic gas and could therefore lead to suffocation and death if there is insufficient air.

Long-term (called chronic) carbon monoxide poisoning is difficult to recognise because it produces similar symptoms to various other illnesses that tend to leave a person in a ‘rundown’ condition.

If you believe that a conscious person has recently been affected by carbon monoxide, then you must:

- remove that person to fresh air and call for medical aid immediately
- make them lie down and rest
- do not let them walk around
- reassure them that they will be okay, and that help is coming
- stay with them and keep a watch on their condition in case they lose consciousness and stop breathing

If you discover an unconscious person and believe it to be carbon monoxide poisoning, or if they lapse into unconsciousness after you have done all of the above, then you must:

- ensure that they are still breathing, and
- place them on their side in the recovery position (so that if they vomit, they will not choke), or
- if they are not breathing you must attempt CPR (Cardio-Pulmonary Resuscitation).

Note: *You will receive CPR training as part of a plumbing, gasfitting and/or drainlaying training programme.*

If you are not a trained in first aid, then you may be afraid at first of attempting CPR. However, if you do nothing that person may die!

If you have no training, ask other people around you if anyone is trained. If there is, hand over to them, but offer to assist. If there is not, you are on your own, but you must do the best you can.

Toxic gas

If you are to work on a site where there is any possibility of accidental exposure to toxic gas, then you should be shown:

- the site evacuation plan
- where the emergency cell phone or landline phone is
- where the emergency services phone numbers are (they should be clearly displayed by the emergency phone)
- Job Safety Analysis

Precautions to take when working where toxic gas may be present

1. Move carbon monoxide-generating processes outside where possible
2. Use electrical, hydraulic or pneumatic tools instead of fuel-powered tools
3. Make sure exposure monitoring/ atmospheric testing is carried out to determine the concentration of carbon monoxide in the workplace
4. Report any suspicious gas smell or leak immediately to the supervisor and stop work
5. Make sure the workplace is well ventilated so there is no accumulation of carbon monoxide gas
6. Wear PPE as necessary (respiratory protective equipment/breathing apparatus)
7. Provide a stand-by/emergency response person

Exposure to toxic gases

In the event of exposure to toxic gases:

- safely remove the person affected from the contaminated area to an area of fresh air, preferably outdoors (and ventilate the affected area if possible)
- administer first aid as required
- seek medical assistance

Confined spaces

The *Guidelines for the Provision of Facilities and General Safety in the Construction Industry* states that confined spaces include open access chambers, trenches, sewers, large pipes and other places where there is inadequate ventilation, and/or the air is either contaminated or oxygen deficient. Confined spaces also include closed tanks with restricted means of entry and exit.

Hazardous confined spaces for drainlayers include access chambers (manholes), tunnels, and trenches set in chalk soil, which can partly fill with carbon dioxide gas, displacing breathable air.

If you have to work in a confined space, then you must comply with:

- The Health and Safety at Work Act 2015 (HSWA)
- AS/NZS 2865:2001 *Safe working in a confined space*.

While working in a sewage holding tank, two workers were overcome by toxic gas and drowned in the sewage. There have been other fatalities following entry into such tanks and also in situations where improperly equipped individuals have attempted to rescue workers in distress.

Source: WorkSafe NZ

Poisonous (toxic) or flammable gases can collect in access chambers in contaminated ground, for example near underground petrol tanks or refuse tips.

There can be a build-up of flammable and/or poisonous gases and/or insufficient oxygen in the air in access chambers, or pits or trenches connected to sewers. If disturbed, sludge and other residues in tanks or pits may partially fill the confined space with dangerous gases.

Rotting vegetation, rusting metal work and similar natural oxidation processes may lead to an oxygen-deficient atmosphere inside the space.

Confined spaces with restricted airflow can allow other gases to build up to the point where the oxygen level is too low to be safe to work in. The other gases may not be detectable by smell.

Gas testing and monitoring

Gas testing/monitoring is the continuous or periodic/short term measurement of oxygen levels or selected atmospheric contaminants over an uninterrupted duration of time.

Before you enter any confined space, it should be tested using gas detectors to check if there are adequate levels of oxygen present, and that dangerous amounts of flammable and/or poisonous gases are not present.

Gas testing is a highly technical skill and it is important that the person with this responsibility is competent and thoroughly trained in the use of the test equipment. No one is to enter any space if testing shows that the air is dangerous inside. Forced ventilation should be used to remove or dilute the gases and supply fresh air. The air should be tested again prior to entering and monitoring continued while work is being conducted inside the space.

The following report describes the lead up to a gas explosion:

A drainlayer who survived an explosion when inspecting the inside of a large pipeline reported that:

“There was a strong smell of gas all week. We weren’t supposed to smoke on the site, but some people still did. We were grinding just before the blast happened. There were sparks.”

The explosion resulted in one colleague’s death and another colleague lost his legs.

(Pipeline accident in Auckland)
Source: New Zealand Herald, 5 June 2011

Activity 3

Correctly complete the following sentences by writing in the missing words.

1. In the event of a gas fire I would:
   a. See if I could safely turn ___ the _____ at the _____ _____.
   b. Check for any _____ fire.
   c. If there is any fire, decide if I could _____ it.
   d. But always call the _____ _____.

2. If it was ground or sewer gas on fire I would:
   a. _____ the building or area.
   b. _____ off the area.
   c. Always call the _____ _____.
   d. _____ _____ until help arrived.

3. If I thought a conscious person had been affected by toxic gas I would:
   a. _____ the person to _____ air immediately and summon _____.
   b. Make them _____.
   c. Not allow them to _____ _____.
   d. _____ _____ them and their condition until help arrived.

4. If a person was unconscious and I believed them to have been affected by poison gas, I would:
   a. Check to see if they were still _____.
   b. If yes, put them in the _____ position.
   c. If not, immediately attempt _____.

Check your answers with your tutor or supervisor.

Got questions?

If you have any questions, please contact your assessor directly.

www.skills.org.nz