Managing risks of hazardous chemicals in the workplace

Code of Practice

NOVEMBER 2026

safe work australia

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Foreword

This Code of Practice on how to manage the risks associated with hazardous chemicals in the workplace is an approved code of practice under section 274 of the *Work Health and Safety Act* (the WHS Act).

An approved code of practice provides practical guidance on how to achieve the standards of work health and safety required under the WHS Act and the *Work Health and Safety Regulations* (the WHS Regulations) and effective ways to identify and manage risks.

A code of practice can assist anyone who has a duty of care in the circumstances described in the code of practice. Following an approved code of practice will assist the duty holder to achieve compliance with the health and safety duties in the WHS Act and WHS Regulations, in relation to the subject matter of the code of practice. Like regulations, codes of practice deal with particular issues and may not cover all relevant hazards or risks. The health and safety duties require duty holders to consider all risks associated with work, not only those for which regulations and codes of practice exist.

Codes of practice are admissible in court proceedings under the WHS Act and WHS Regulations. Courts may regard a code of practice as evidence of what is known about a hazard, risk, risk assessment or risk control and may rely on the code in determining what is reasonably practicable in the circumstances to which the code of practice relates. For further information see the Interpretive Guideline: *The meaning of 'reasonably practicable'*.

Compliance with the WHS Act and WHS Regulations may be achieved by following another method if it provides an equivalent or higher standard of work health and safety than the code.

An inspector may refer to an approved code of practice when issuing an improvement or prohibition notice.

Scope and application

This Code is intended to be read by a person conducting a business or undertaking (PCBU). It provides practical guidance to PCBUs on how to manage health and safety risks associated with hazardous chemicals used in their workplace.

A PCBU can be a manufacturer, importer or supplier of hazardous chemicals, or a business owner who uses, handles, generates or stores hazardous chemicals at their workplace. They may also be more than one of these things.

This Code may be a useful reference for other persons interested in the duties under the WHS Act and WHS Regulations.

This Code applies to all types of work and all workplaces covered by the WHS Act.

This Code applies to:

- substances, mixtures and articles used, handled, generated or stored at the workplace which are defined as hazardous chemicals under the WHS Regulations
- the generation of hazardous chemicals from work processes, for example toxic fumes released during welding.

This Code does not apply to the transportation of dangerous goods or explosives which are subject to state and territory laws based on the requirements under the *Australian Code for the Transport of Dangerous Goods by Road and Rail* (ADG Code) and the *Australian Code for the Transport of Explosives by Road and Rail 3rd edition*. Most substances and mixtures that are dangerous goods under the ADG Code are also hazardous chemicals. All PCBUs have a responsibility under WHS laws to manage the risks from hazardous chemicals, including those that are also dangerous goods.

Manufacturers, importers or suppliers of hazardous chemicals that are used, or are likely to be used, in workplaces should refer to the following Codes of practice:

- Preparation of safety data sheets (SDS) for hazardous chemicals, and
- Labelling of workplace hazardous chemicals.

A PCBU who uses, handles or stores hazardous chemicals listed in Schedule 14 of the WHS Regulations should also refer to the Safe Work Australia Guidance materials for health monitoring.

A PCBU who operates a licensed major hazard facility or uses, handles or stores hazardous chemicals at or above 10 per cent of the prescribed threshold quantities in Schedule 15 of the WHS Regulations should also refer to the Safe Work Australia's Guidance materials for major hazard facilities.

Guidance for work involving asbestos or asbestos-containing materials is available in the following Codes of practice:

- How to manage and control asbestos in the workplace, and
- How to safely remove asbestos.

Guidance for work involving silica or silica containing products is available in the Code of Practice on Managing the risks of respirable crystalline silica from engineered stone in the workplace.

Implementation of the Globally Harmonized System of Classification and Labelling of Chemicals (GHS)

The WHS Regulations implement a system of chemical hazard classification, labelling and SDS requirements based on the 7th revised edition of the Globally Harmonized System of Classification and Labelling of Chemicals (GHS). See using the GHS and classifying chemicals in Australia for further information.

How to use this Code of Practice

This Code includes references to the legal requirements under the WHS Act and WHS Regulations. These are included for convenience only and should not be relied on in place of the full text of the WHS Act or WHS Regulations. The words 'must', 'requires' or 'mandatory' indicate a legal requirement exists that must be complied with.

The word 'should' is used in this Code to indicate a recommended course of action, while 'may' is used to indicate an optional course of action.

1. Introduction

1.1 What are hazardous chemicals?

Under the WHS Regulations, a hazardous chemical is any substance, mixture or article that satisfies the criteria of one or more hazard classes in the GHS, as modified by Schedule 6 of the WHS Regulations. However, some hazard classes and categories of the GHS are excluded by the WHS Regulations. See Appendix A for the definition of 'hazardous chemical' and other terms used in this Code.

Most substances, mixtures, and articles that are dangerous goods under the *Australian Code for the Transport of Dangerous Goods by Road and Rail* (ADG Code) are hazardous chemicals, except those that have only radioactive hazards (class 7 dangerous goods), infectious substances (division 6.2) and most class 9 (miscellaneous) dangerous goods.

A comparison of dangerous goods classifications under the ADG Code with those under the GHS is provided on the Safe Work Australia website.

In relation to chemicals, a **hazard** is a set of intrinsic properties of the substance, mixture, article or process that may cause adverse effects to organisms or the environment. There are two broad types of hazards associated with hazardous chemicals which may present an immediate or long-term injury or illness to people. These are:

- **Health hazards**—These are properties of a chemical that cause adverse health effects. Exposure usually occurs through inhalation, skin contact or ingestion. Adverse health effects can be acute (short term) or chronic (long term). Typical acute health effects include headaches, nausea or vomiting and skin corrosion, while chronic health effects include asthma, dermatitis, nerve damage or cancer. Examples of chemicals with health hazards include acutely toxic chemicals, carcinogens (cancer-causing chemicals) and reproductive toxicants (chemicals which may cause infertility or birth defects).
- **Physical hazards**—These are properties of a chemical that can result in immediate injury to people or damage to property. They arise through inappropriate handling or use and can often result in injury to people and/or damage to property as a result of the intrinsic physical hazard. Examples of physical hazards include flammable, corrosive, explosive, chemically-reactive and oxidising chemicals.

Many chemicals have properties that make them both health and physical hazards.

The **risk** from a chemical is different to the hazard. Risk is the possibility that harm (death, injury or illness) might occur when exposed to a hazard. The level of risk depends on how serious the harm could be and the likelihood of it happening.

1.2 Who has health and safety duties in relation to hazardous chemicals?

Duty holders who have a role in managing the risks of hazardous chemicals include:

- persons conducting a business or undertaking (PCBUs)
- designers, manufacturers, importers, suppliers and installers of plant, substances or structures, and
- officers.

Workers and other persons at the workplace also have duties under the WHS Act, such as the duty to take reasonable care for their own health and safety at the workplace.

A person can have more than one duty and more than one person can have the same duty at the same time.

Early consultation and identification of risks can allow for more options to eliminate or minimise risks and reduce the associated costs.

Person conducting a business or undertaking

WHS Act Section 19

Primary duty of care

Under the WHS Act, a PCBU has the primary duty to ensure, so far as is reasonably practicable, that the health and safety of workers and other persons are not put at risk from work carried out as part of the conduct of the business or undertaking. This includes ensuring the safe use, handling and storage of substances.

A PCBU must eliminate risks arising from hazardous chemicals in the workplace, or if that is not reasonably practicable, minimise the risks so far as is reasonably practicable.

PCBUs have a duty to consult workers about work health and safety and may also have duties to consult, cooperate and coordinate with other duty holders.

WHS Regulations Part 7.1

Hazardous Chemicals

The WHS Regulations include a number of specific duties for a PCBU to manage the risks to health and safety associated with using, handling, generating and storing hazardous chemicals at a workplace. The duties include:

- correct labelling of containers and pipework, using warning placards and outer warning placards and displaying of safety signs
- maintaining a register and manifest (where relevant) of hazardous chemicals and providing notification to the regulator of manifest quantities if required
- identifying risk of physical or chemical reaction of hazardous chemicals and ensuring the stability of hazardous chemicals
- provision of appropriate personal protective equipment (PPE)
- ensuring that exposure limits are not exceeded

- provision of health monitoring to workers
- provision of information, training, instruction and supervision to workers
- provision of spill containment system for hazardous chemicals if necessary
- obtaining the current safety data sheet (SDS) from the manufacturer, importer or supplier of the chemical and making the SDS readily available to workers
- controlling ignition sources and accumulation of flammable and combustible substances
- provision and availability of fire protection, firefighting equipment, emergency equipment and safety equipment
- preparing an emergency plan, and if the quantity of a class of hazardous chemical at a workplace exceeds the manifest quantity for that hazardous chemical, providing a copy of the emergency plan to the primary service organisation
- stability and support of containers for bulk hazardous chemicals including pipework and attachments
- decommissioning of underground storage and handling systems
- notifying the regulator as soon as practicable of abandoned tanks in certain circumstances.

These duties under the WHS Regulations do not apply to some hazardous chemicals at the workplace in certain circumstances. These circumstances are listed in regulation 328 of the WHS Regulations, and include:

- hazardous chemicals and explosives being transported if the transport is regulated under another safety law
- hazardous chemicals in batteries when incorporated in plant
- hazardous chemicals in portable firefighting or medical equipment for use in a workplace
- potable liquids that are consumer products at retail premises
- food and beverages within the meaning of the Food Standards *Australia New Zealand Food Standards Code* that are in a package and form intended for human consumption
- tobacco or products made of tobacco
- therapeutic goods within the meaning of the *Therapeutic Goods Act 1989 (Commonwealth)* at the point of intentional intake by or administration to humans
- veterinary chemical products within the meaning of the *Agricultural and Veterinary Chemicals Code Act* at the point of intentional administration to animals.

The WHS Regulations contain prohibitions or restrictions on certain hazardous chemicals (for example certain carcinogens) except in specified circumstances and a restriction on the age of a person who can supply hazardous chemicals.

There are also duties relating to the building, operation and management of pipelines used for the transfer of hazardous chemicals.

Designers, manufacturers, importers and suppliers of hazardous chemicals

WHS Act Part 2 Division 3

Further duties of persons conducting businesses or undertakings

Designers, manufacturers, importers and suppliers of substances must also ensure, so far as is reasonably practicable, that the substance they design, manufacture, import or supply is without risks to health and safety. This duty includes carrying out testing and analysis as well as providing specific information about the substance. Under the WHS Regulations, manufacturers and importers must correctly classify hazardous chemicals.

WHS Regulations Part 7.1 Division 2

Obligations relating to safety data sheets and other matters

The WHS Regulations also impose duties on importers, manufacturers and suppliers relating to the preparation of SDS, the disclosure of ingredients, packing, labelling and supply of hazardous chemicals.

Officers

WHS Act section 27

Duty of officers

Officers, for example company directors, have a duty to exercise due diligence to ensure the PCBU complies with the WHS Act and WHS Regulations. This includes taking reasonable steps to ensure the business or undertaking has and uses appropriate resources and processes to eliminate or minimise risks that arise from hazardous chemicals at the workplace. Further information on who is an officer and their duties is available in the Interpretive Guideline: *The health and safety duty of an officer under section 27*.

Workers

WHS Act section 28

Duties of workers

Workers have a duty to take reasonable care for their own health and safety and to not adversely affect the health and safety of other persons. Workers must comply with reasonable instructions, as far as they are reasonably able, and cooperate with reasonable health and safety policies or procedures that have been notified to workers. If personal protective equipment (PPE) is provided by the business or undertaking, the worker must so far as they are reasonably able, use or wear it in accordance with the information and instruction and training provided.

Other persons at the workplace

WHS Act Section 29

Duties of other persons at the workplace

Other persons at the workplace, like visitors, must take reasonable care for their own health and safety and must take reasonable care not to adversely affect other people's health and safety. They must comply, so far as they are reasonably able, with reasonable instructions given by the PCBU to allow that person to comply with the WHS Act.

1.3 What is required to manage the risks associated with hazardous chemicals?

This Code provides guidance on how to manage the risks associated with hazardous chemicals in the workplace using the following systematic process:

- Identify hazards—find out what could cause harm
- Assess risks, if necessary—understand the nature of the harm that could be caused by the hazard, how serious the harm could be and the likelihood of it happening. This step may not be necessary if you are dealing with a known risk with known controls
- Eliminate risks so far as is reasonably practicable
- Control risks—if it is not reasonably practicable to eliminate the risk, implement the most effective control measures that are reasonably practicable in the circumstances in accordance with the hierarchy of control measures, and ensure they remain effective over time
- Review control measures to ensure they are working as planned.

Hierarchy of control measures

The WHS Regulations require duty holders to work through the hierarchy of control measures when managing certain risks; however, it can be applied to any risk. The hierarchy ranks control measures from the highest level of protection and reliability to the lowest. You must, so far as is reasonably practicable:

- first, eliminate risks by eliminating hazards; this is the most effective control measure
- then substitute hazards with something safer, isolate hazards from people and/or use engineering controls to minimise any risks that have not been eliminated
- then use administrative controls to minimise any remaining risks, and
- then use PPE to minimise any risks that remain.

The control measures you apply may change the way work is carried out. In these situations, you must consult your workers and develop safe work procedures, and provide your workers with training, instruction, information and supervision on the changes.

Further guidance on the risk management process and the hierarchy or control measures is in the *Code of Practice: How to manage work health and safety risks*.

Consulting, cooperating and coordinating activities with other duty holders

WHS Act section 46

Duty to consult with other duty holders

The WHS Act requires a PCBU to consult, cooperate and coordinate activities with all other persons who have a work health or safety duty in relation to the same matter, so far as is reasonably practicable.

There is often more than one business or undertaking involved when working with hazardous chemicals, that may each have responsibility for the same health and safety matters, either because they are involved in the same activities or share the same workplace.

In these situations, each duty holder should exchange information to find out who is doing what and work together in a cooperative and coordinated way so risks are eliminated or minimised so far as is reasonably practicable.

For example if you engage a contractor to carry out work that involves the use of hazardous chemicals you should consult with other duty holders on site to ensure they are aware of the chemical use and cooperate with each other to ensure that each of their activities do not create risks for workers on the site.

Further guidance on consultation is available in the *Code of Practice: Work health and safety consultation, cooperation and coordination*.

Consulting with workers

WHS Act section 47

Duty to consult workers

A PCBU must consult, so far as is reasonably practicable, with workers who carry out work for the business or undertaking and who are (or are likely to be) directly affected by a health and safety matter.

This duty to consult is based on the recognition that worker input and participation improves decision-making about health and safety matters and assists in reducing work-related injuries and disease.

The broad definition of a ‘worker’ under the WHS Act means a PCBU must consult, so far as is reasonably practicable, with contractors and subcontractors and their employees, on-hire workers, outworkers, apprentices, trainees, work experience students, volunteers and other people who are working for the PCBU and who are, or are likely to be, directly affected by a health and safety matter.

Workers are entitled to take part in consultations and to be represented in consultations by a health and safety representative who has been elected to represent their work group.

1.4 Prohibited and restricted hazardous chemicals

The WHS Regulations prohibit or restrict the use, storage or handling of certain hazardous chemicals in certain situations. For example, substances containing arsenic must not be used in spray painting or abrasive blasting, while a number of carcinogens such as 4-nitrodiphenyl are prohibited from all uses except for genuine research or analysis authorised by the regulator. Certain chemicals can be used, handled or stored in the workplace after receiving approval from the regulator. Schedule 10 of the WHS Regulations provides further information on the hazardous chemicals that are restricted or prohibited for use (see Carcinogens webpage).

1.5 Exposure limits and air monitoring

WHS Regulation 49

Ensuring exposure limits for substances and mixtures not exceeded

A PCBU must ensure that no person at the workplace is exposed to a substance or mixture in an airborne concentration that exceeds the relevant exposure limit for the substance or mixture.

WHS Regulation 50

Duty to conduct air monitoring

The WHS Regulations require air monitoring for chemicals with exposure limits (known as airborne contaminants) to be carried out, if:

- you are not certain on reasonable grounds whether or not the airborne concentration of the substance or mixture at the workplace exceeds the relevant exposure limit, or
- monitoring is necessary to determine if there is a risk to health.

Not all work involving airborne contaminants will require air monitoring. You should conduct a risk assessment to determine if air monitoring is required. Air monitoring may also assist in identifying risks to workers' health from airborne contaminants and the effectiveness of the controls in place to manage those risks.

Exposure limits

Exposure limits represent the airborne concentration of a particular substance or mixture a person is exposed to that must not be exceeded. There are three types of exposure limit:

- 8-hour time weighted average (8-hr TWA) exposure limit: the maximum permitted concentration of an airborne contaminant calculated as a time weighted average for an 8-hour working day, based on a 5-day working week (40 hours).
- short term exposure limit (STEL): the maximum permitted concentration of an airborne contaminant calculated as a time weighted average over a 15-minute period, and
- peak limitation: the maximum permitted concentration of an airborne contaminant measured over the shortest analytically practicable time possible, and not exceeding 15 minutes,

Exposure limits are the maximum level of an airborne contaminant that most (but not all) people can be exposed to via inhalation without harm to their health. These limits are based on current knowledge and are designed to prevent health issues or discomfort for nearly all workers. They are not a target or safe level – you must keep exposure as low as reasonably practicable, not just below the limit.

Exposure limits apply to substances entering the body via inhalation. Exposure to substances in the workplace can also occur through skin absorption or ingestion (eating or drinking).

Chemicals with workplace exposure limits are listed in the *Workplace exposure limits for airborne contaminants*. These exposure limits are also available from the Hazardous Chemical Information System (HCIS), which also contains additional information and guidance for many substances. Although exposure limits may also be listed in Section 8 of the SDS, you should always check the *Workplace exposure limits for airborne contaminants* or HCIS to be certain.

There are a group of chemicals, known as non-threshold genotoxic carcinogens (NTGCs), for which practical, protective workplace exposure limits cannot be assigned at this time. Exposure to these substances can cause genetic damage and may lead to cancer. Given the nature of how NTGCs cause harm and limitations in available data, a 'safe' exposure threshold is not able to be established. NTGCs are listed in Appendix B of the *Workplace Exposure Limits for Airborne Contaminants*. These substances pose a significant risk to workers and PCBUs have a duty to eliminate risks from NTGCs so far as is reasonably practicable. If elimination is not reasonably practicable, the risk of exposure must be minimised as far as reasonably practicable.

Even in the absence of an exposure limit, if there is a way to measure an airborne contaminant, i.e. there is a sampling and analysis method, you may still conduct air monitoring to demonstrate exposure is minimised as far is reasonably practicable.

Further information on the workplace exposure limits can be found in the *Guide for PCBUs: Air monitoring and workplace exposure limits for airborne contaminants,* and *the Technical guide: Air monitoring and workplace exposure limits for airborne contaminants*.

1.6 Preparing a register and manifest of hazardous chemicals

WHS Regulation 346

Hazardous chemicals register

A PCBU must ensure that a register of hazardous chemicals at the workplace is prepared and kept up to date. The register must be readily accessible to workers involved in using, handling or storing hazardous chemicals and to anyone else who is likely to be affected by a hazardous chemical at the workplace.

The register is a list of the product names of all hazardous chemicals used, handled or stored at the workplace accompanied by the current SDS for each hazardous chemical listed. It must be updated as new hazardous chemicals are introduced to the workplace or when the use of a particular hazardous chemical is discontinued.

More information about hazardous chemical registers can be found in the *Hazardous Chemical Register Fact Sheet*.

Manifest of Schedule 11 hazardous chemicals

WHS Regulation 347

Manifest of hazardous chemicals

A PCBU must prepare a manifest of Schedule 11 hazardous chemicals at the workplace.

A manifest is different from a register. A manifest is a written summary of specific types of hazardous chemicals with physical hazards, acute toxicity or skin corrosion that are used, handled or stored at a workplace. A manifest is only required where the quantities of those hazardous chemicals exceed prescribed threshold amounts. It contains more detailed information than a register of hazardous chemicals as its primary purpose is to provide the emergency services organisations with information on the quantity, classification and location of hazardous chemicals at the workplace. It also contains information such as site plans and emergency contact details.

The manifest must comply with the requirements of Schedule 12 of the WHS Regulations and it must be updated as soon as practicable after any change to the amount or types of chemicals being used, stored, handled or generated at the workplace.

A manifest quantity is the quantity referred to in Schedule 11 of the WHS Regulations, table 11.1, column 5 for that hazardous chemical also available at - Placard and manifest threshold quantities.

2. Identifying hazards

2.1 Types of hazards

There are two broad types of hazards associated with hazardous chemicals which may present an exposure risk to people. In the WHS Regulations, hazards are classified in accordance with the GHS. The National Guide on Classifying hazardous chemicals provides more information about how chemicals are classified based on their hazardous properties.

Health hazards

These are properties of a chemical that cause adverse health effects. Exposure usually occurs through inhalation, skin contact or ingestion.

Adverse health effects can be acute (short term) or chronic (long term). Acute health effects can include headaches, nausea or vomiting and skin corrosion, while chronic health effects include asthma, dermatitis, nerve damage or cancer. Under the GHS, chemicals can be classified as having health hazards of:

- **Acute toxicity (oral, dermal or inhalation)** for chemical which can be fatal, toxic or harmful if swallow, through contact with the skin, or if inhaled
- **Skin corrosion or irritation** for chemicals which can cause skin irritation or severe skin burns and eye damage
- **Serious eye damage or eye irritation**
- **Respiratory or skin sensitisation** for chemicals which can cause allergy or asthma symptoms or breathing difficulties if inhaled, or cause an allergic skin reaction
- **Germ cell mutagenicity** for chemicals which can cause genetic defects
- **Carcinogenicity** for chemicals which can cause cancer
- **Reproductive toxicity** which are chemicals which can damage fertility or the developing foetus or cause harm to breast-fed children
- **Specific target organ toxicity (single exposure)** for chemicals which can:
    - cause damage to organs
    - cause respiratory irritation
    - cause drowsiness or dizziness
- **Specific target organ toxicity (repeated exposure)** for chemicals which can cause damage to organs through prolonged or repeated exposure
- **Aspiration** for chemicals which can be fatal if swallowed and enters airways.

Physical hazards

These are properties of a chemical that can result in immediate injury to people or damage to property. Under the GHS chemicals can be classified as having physical hazards of:

- **Explosives**
- **Flammable gases** which include:
    - gases which can ignite spontaneously if exposed to air
    - gases which can react explosively in the absence of air
- **Aerosols** which can be a flammable or non-flammable chemical in a pressurised container that may burst if heated
- **Oxidising gases** which can cause or intensify fires
- **Gases under pressure** which can explode if heated, or cause cryogenic burns or injury
- **Flammable liquids**
- **Flammable solids**
- **Self-reactive substances and mixtures** and **organic peroxides**, which are chemicals which heating can cause a fire and/or explosion
- **Pyrophoric liquids** and **pyrophoric solids,** which are chemicals which can catch fire spontaneously if exposed to air
- **Self-heating substances and mixtures,** which are chemicals capable of self-heating, which can lead to fires
- **Substances and mixtures which, in contact with water, emit flammable gases**
- **Oxidising liquids** and **oxidising solids,** which are chemicals which may cause or intensify a fire or explosion by providing oxygen
- **Corrosive to metals**
- **Desensitised explosives,** which are chemicals which have a fire, blast or projection hazard which has an increased risk of explosion if desensitising agent is reduced.

2.2 How to identify which chemicals are hazardous

The first step in managing risks involves identifying all the chemicals that are or are likely to be used, handled, stored or generated at your workplace in consultation with workers. The identity of chemicals in the workplace can usually be determined by looking at the label and the SDS, and reading what ingredients are in each chemical or product. In some cases, a chemical may not have a label or an SDS, for example where fumes are generated in the workplace from an activity such as welding.

A manufacturer or importer must determine the hazards of a chemical against specified criteria. This process is known as classification, and it is the hazard classification of a chemical that determines what information must be included on labels and SDS, including the type of label elements, hazard statements and pictograms. Manufacturers and importers are required to prepare labels and SDS, and must regularly review the information on them to ensure it is correct and up to date; for example, new information on a chemical may lead to a change in its hazard classification.

Specific guidance on what a manufacturer or importer must include in an SDS and label can be found in:

- *Code of Practice: Preparation of safety data sheets for hazardous chemicals, and*
- *Code of Practice: Labelling of workplace hazardous chemicals*.

As a person conducting a business or undertaking (PCBU), you should always read the label in conjunction with the SDS to make sure all chemical hazards are identified. In some cases, designers, manufacturers, importers and suppliers do not have a duty to provide this information as an SDS or label, for example with welding rods. In these cases SDS or product specification sheets, can still be produced as an effective way to communicate information downstream about the risks when working with such solid products and it is considered good practice to make them available. You may also need to research other sources such as codes of practice or guidance documents on the process.

The manufacturer, importer or supplier may provide further information about the hazardous chemical. Information on chemicals can also be found in the HCIS database.

Hazardous chemicals that are contained in plant forming part of a manufacturing process, such as a piping system, must also be identified. This is to ensure controls can be implemented in the event of an accidental rupture or spill or when maintenance or cleaning is required.

Hazardous chemicals generated in the workplace

Some processes will produce hazardous chemicals as by-products or waste. These hazards may not be easily identified when generated at the workplace, for example hydrogen sulfide in a sewer or diesel engine emissions from truck engines. Information on by-products may be available from an SDS, but not always.

You should find out what hazardous chemicals may be produced from work activities, for example:

- welding, plasma cutting and arc gouging may generate toxic fumes and vapours,
- grinding metals may release toxic metal dust or fumes,
- cutting or crushing concrete blocks or bricks may release hazardous dusts including respirable crystalline silica (RCS),
- off-gassing of solvent vapours from glues used to manufacture timber products such as Medium Density Fibreboard (MDF), or
- dusts released from machining timbers are hazardous to health or can present a dust explosion risk.

If you generate hazardous chemicals in the workplace, you must manage the risks associated with those chemicals. Some of these hazardous chemicals may have exposure limits in the *Workplace exposure limits for airborne contaminants*.

2.3 Labels

WHS Regulations Part 7.1 Division 2

Obligations relating to safety data sheets and other matters

The manufacturer and importer of a hazardous chemical must ensure it is correctly labelled as soon as practicable after manufacturing or importing the hazardous chemical.

As a PCBU that uses, handles or stores hazardous chemicals, you must ensure that any hazardous chemical that is used, handled or stored at the workplace is correctly labelled in accordance with the WHS Regulations.

You must also ensure, so far as is reasonably practicable, that a hazardous chemical in pipe work is identified by a label, sign or another way on or near the pipe work.

Labels are generally the first place you and your workers may look to identify whether a chemical is hazardous. Labels provide important information on what the hazards of the chemical are, and the nature and severity of the hazards.

For more information on labelling of hazardous chemicals, refer to the Code of Practice: *Labelling of workplace hazardous chemicals*.

Table 1 below shows examples of elements on a label that indicate the type of hazard and the severity of the hazard.

Table 1 Examples of hazard information on a label

Label element	Examples		
Signal words These provide an immediate warning to the reader	• Danger or Warning		
Hazard statements These describe the nature and severity of the chemical hazard based on a chemical's classification	• May cause cancer • Fatal if inhaled • Flammable liquid and vapour • Causes severe skin burns and eye damage • May cause respiratory irritation		
Pictograms These provide a pictorial representation of the type of hazard that can be easily recognised at a glance			
	Flame	Skull and crossbones	Exclamation mark
			
	Health hazard	Corrosion	

Chemicals labelled under other regulations

In general, a label is required for any substance, mixture or article that meets the definition of a hazardous chemical under the WHS Regulations. However, there are instances where chemicals are excluded from the labelling requirements under the WHS Regulations.

In circumstances where a chemical is labelled in accordance with other regulations, it may not contain all the hazard information. For example:

- some consumer products, agricultural or veterinary chemical products labelled in accordance with the requirements for those products,
- where the label is too small to fit all relevant hazard information, or
- when hazardous chemicals that are dangerous goods are labelled to meet transport requirements.

These labels may still be used to help identify the hazards of the chemical. You should also refer to the SDS in addition to reading the label to ensure all hazards are identified.

In these cases, you must check if you are required to label these chemicals in accordance with the WHS Regulations in addition to their existing labels. The *model Code of Practice: Labelling of workplace hazardous chemicals* provides guidance on when this is necessary,

Incorrectly labelled or unlabelled containers

If you find a container that does not have a label or is incorrectly labelled, action must be taken to correctly label the container. Containers that have had chemicals transferred into them (decanted) in the workplace, and containers of chemical wastes must be labelled correctly.

If the contents of the container are not known, this should be clearly marked on the container, for example, 'Caution—do not use: unknown substance'. Such a container should be stored in isolation until its contents can be identified and, if it is then found to be hazardous, the container can be appropriately labelled. If the contents cannot be identified, they should be disposed of in accordance with relevant local waste management requirements.

2.4 Safety Data Sheets

WHS Regulations Part 7.1 Division 2

Obligations relating to safety data sheets and other matters

The manufacturer or importer must prepare an SDS for the hazardous chemical before first manufacturing or importing the hazardous chemical or as soon as practicable after the first manufacturing or importing and before first supplying it to a workplace.

As a PCBU, you must obtain the SDS (and any amended version) for a hazardous chemical from the manufacturer, importer or supplier no later than when the chemical is first supplied at the workplace or as soon as practicable after it is first supplied, but before it is used at the workplace.

You can use the SDS to assist in the identification of hazards in your workplace, their associated risks, and controls that you may think about implementing in your workplace. An SDS will include information describing:

- the chemical's identity and ingredients
- the chemical's GHS hazard classification
- safe handling and storage procedures
- emergency procedures, and
- disposal considerations.

Important hazard information to note from the SDS is listed in Table 2. More information regarding the preparation and contents of an SDS can be found in the Code of Practice: *Preparation of safety data sheets for hazardous chemicals*.

Table 2 Information given in the SDS which can help to identify health and physical hazards

Section 1 Identification	• **Product identifier and other names** • **Recommended use – are you using the chemical correctly?** • **Restrictions on use – such as Schedule 10 restricted or prohibited carcinogens**

Section 2
Hazard identification
	• Classification (e.g. Flammable liquid – Category 1)
	• Label elements such as:
	  ◦ Signal word (e.g. Danger)
	  ◦ Hazards statements (e.g. Toxic if swallowed)

Section 3 Composition and information on ingredients	• All hazardous ingredients • Other (non-hazardous) ingredients may be included • Percentage of each ingredient • Generic names may be included
Section 4 First aid measures	• Information on route of entry to the body of the chemical • Lists symptoms which may be caused by exposure
Section 7 Handling and storage	• Information on precautions for safe handling • Conditions for safe storage, including any incompatibilities
Section 8 Exposure controls and personal protection	• Lists the workplace exposure limit • Lists suggested controls and personal protective equipment

Section 9
Physical and chemical properties
	• Information about physical risks such as:
	  ◦ Flammability
	  ◦ Density of substance (asphyxiation risk)
	  ◦ Explosivity

Section 10
Stability and reactivity
	• Information about conditions that may create physical and health risks such as:
	  ◦ Reactivity of the chemical
	  ◦ Stability of the chemical

	○ Possibility of hazardous reactions ○ Conditions to avoid when using or storing the chemical ○ Incompatible materials ○ Hazardous products produced due to decomposition
Section 11 Toxicological information	• Information relating to the health risks of the chemical such as: • More information on hazard statements • Information on routes of exposure • Information on early onset and delayed symptoms of exposure • Exposure levels • Interactive effects and mixtures

If you are using a consumer or domestic chemical for its usual purpose (for example, washing dishes in the lunchroom) you will not need to obtain an SDS. However, chemicals which are generally for domestic use and considered safe in the home may present greater risks in the workplace depending on the manner and quantities in which they are used. This is particularly relevant, for example, where domestic cleaning chemicals are purchased from a supermarket and used at a workplace in a way or quantity which is not consistent with home use.

If you are using a domestic chemical in a manner different to normal household use, you should obtain the SDS in order to determine the level of risk to workers and the appropriate controls. The SDS should contain more detailed information on hazards and risks, for example on incompatibilities with other chemicals and risks from use in enclosed areas.

Providing access to SDS in the workplace

WHS Regulation 344

Person conducting business or undertaking to obtain and give access to safety data sheets

You must ensure the current SDS is readily accessible to workers involved in using, handling or storing the hazardous chemical at the workplace and emergency service workers, or anyone else who is likely to be exposed to the hazardous chemical.

The SDS should be kept in a location near the work area where the substance is used—this may be as hard copy or in another format, including electronically. You must ensure that all workers likely to be exposed to the hazardous chemical know how to find the SDS.

In some cases, it may be practicable to provide workers with access to SDS via an electronic database, for example in universities where potentially thousands of chemicals may be used, stored or handled at the site. However, the electronic database should be readily available to workers, workers should know how to use it, and a backup means of providing the SDS should also be provided, for example as hard copies in a filing system.

This requirement does not apply to hazardous chemicals and consumer products in certain circumstances. For more information refer to the Code of Practice: *Preparation of safety data sheets for hazardous chemicals*.

2.5 Hazardous Chemical Information System

The Hazardous Chemical Information System (HCIS) is an internet advisory service that provides information on chemicals that have been classified in accordance with the GHS by an authoritative source, such as the European Chemicals Agency (ECHA) or the Australian Industrial Chemicals Introduction Scheme (AICIS). HCIS also includes the workplace exposure limits from the *Workplace exposure limits for airborne contaminants*.

2.6 Hazard information in the *Workplace exposure limits for airborne contaminants*

The *Workplace exposure limits for airborne contaminants* provides advice, via notations, about additional risks some chemicals with exposure limits may pose.

- There are 4 types of notations:
- Sk: absorption through the skin may be a significant source of exposure
- DSEN: substances that cause sensitisation through dermal (skin) absorption
- RSEN: substances that cause sensitisation through respiratory tract exposure
- OTO: ototoxic substance. Exposure can increase the risk of hearing loss. More information about ototoxicity can be found in the *Code of Practice: Managing noise and preventing hearing loss at work*.

Further information about these notations can be found in:

- *A guide for PCBUs: Air monitoring and workplace exposure limits for airborne contaminants,* and
- *A technical guide: Air monitoring and workplace exposure limits for airborne contaminants*.

2.7 Other sources of information

Additional information regarding hazards and risks associated with the use, handling, generation and storage of hazardous chemicals can be obtained from the following sources:

- incident records
- previous risk assessments
- the Australian Code for the Transport of Dangerous Goods by Road and Rail
- the Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP)
- Australian Industrial Chemicals Introduction Scheme (AICIS)
- European Chemicals Agency (ECHA)
- WHS regulators
- trade unions
- employer associations
- work health and safety consultants, and
- internet searches of authoritative websites, such as those of international work health and safety agencies like the US Occupational Safety and Health Administration (OSHA), or the European Commission Joint Research Centre's Institute for Health and Consumer Protection.

3. The risk management process

A risk assessment is not mandatory for hazardous chemicals under the WHS Regulations. However, in many circumstances it will be the best way for you, as a person conducting a business or undertaking (PCBU), to determine the measures that should be implemented to control risks. It will help you to:

- identify which workers are at risk of exposure
- determine what sources and processes are causing that risk
- identify if and what kind of control measures should be implemented, and
- check the effectiveness of existing control measures.

Where the hazards and associated risks are well known and have well established and accepted control measures, it may not be necessary to undertake a risk assessment, for example, where there are a small number of chemicals in a workplace and the hazards and risks are well understood. If after identifying a hazard you already know the risk and how to control it effectively, you may simply implement the controls.

Your risk assessment should also consider foreseeable failures of plant and equipment, as well as any control measures, for example:

- A power failure may impact on the operation of a mechanical ventilation system at the workplace.
- Accidental spills have the potential to corrode or impact on nearby plant or equipment.

Documenting risk assessments is not mandatory, but may help when reviewing where improvements can be made and risks controlled more effectively.

Appendix B provides an overview and Appendix C provides a checklist of the risk assessment process.

Further guidance on the risk management process and the hierarchy of control measures is available in the *Code of Practice*: How to manage work health and safety risks.

3.1 Decide who should do the assessment

Assessments are based on a thorough understanding of what happens, or might happen, in the workplace and should be carried out by a person or persons who have:

- a practical understanding of the WHS laws, codes of practice and relevant guidance materials
- an understanding of the work processes involved at the workplace, and
- enough resources to gather information, consult the appropriate people, review existing records and examine the workplace.

The person or persons should also have abilities to:

- interpret the information on the label and SDS of the hazardous chemical
- observe the conditions of work, and to foresee potential problems
- communicate effectively and where appropriate consult with manufacturers, importers, suppliers, managers, technical specialists and workers including contract workers

- draw all the information together in a systematic way to form valid conclusions about exposures and risks, and
- accurately report the findings to all parties concerned.

A single person such as a supervisor may be suitably competent to perform simple assessments. In more complex cases, several persons representing a variety of skills may need to be involved in collecting and assessing the information. Whether a single person or multiple people undertake the assessment, they should consult with workers and their health and safety representatives.

Seeking external assistance

In some cases, it may be necessary to seek external professional assistance to assist or undertake risk assessments or air monitoring.

If you engage a consultant to undertake air monitoring, they should be competent. To confirm this, you should ask to see evidence of their qualifications and experience. An example of a competent person is an occupational hygienist[1].

Occupational hygienists can help identify hazards, assess exposure risks, and recommend effective control strategies tailored to your workplace. They can also evaluate the effectiveness of any current controls you have in place

External professional assistance may also be required in the design, installation and maintenance of control measures, such as ventilation systems or fire protection systems.

3.2 Decide what sort of risk assessment is appropriate

The type of risk assessment that should be conducted will depend on the nature of the work being performed.

A basic assessment consists of:

- reviewing the labels and the SDS of the hazardous chemicals and assessing the risks involved in their use, and
- deciding whether the hazardous chemicals in the workplace are already controlled with existing control measures, as recommended in the SDS or other reliable sources, or whether further control measures are needed.

For example, the SDS and label might report that a cleaning agent has potential skin irritation effects and may liberate a toxic gas when in contact with certain other chemicals, while it in itself is non-volatile. A basic assessment might indicate that you should, as part of your duties to manage risks to health and safety associated with using, handling, generating or storing a hazardous chemical at a workplace, implement control measures such as requiring the use of protective clothing and gloves, and requiring the chemical to be kept away from incompatible materials.

In **a generic assessment**, an assessment is made of a particular workplace, area, job or task and the assessment is then applied to similar work activities that involve the use of the chemical being assessed.

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[1] *Best practice is to use a certified occupational hygienist. Where a certified occupational hygienist is not available, a person with relevant qualifications and experience in occupational hygiene or a person under the supervision of a certified occupational hygienist is acceptable.*

For example, a business or industry association might do a generic assessment for a number of workplaces that use, handle, generate or store identical chemicals (such as service stations or dry cleaners). When conducting a generic assessment, it is important that the workplace, tasks and hazardous chemicals being assessed are identical in characteristics, properties, potential hazards and risks. Generic assessments are not appropriate for very high risk chemicals such as carcinogens.

A detailed assessment may be needed when there is a significant risk to health and for very high risk chemicals such as carcinogens, mutagens, reproductive toxicants or sensitisation agents in the case of health hazards. Information on the label and SDS will allow you to determine whether the chemical has these hazards. Schedule 10 of the WHS Regulations provides further information on the hazardous chemicals that are restricted or prohibited for use (see Carcinogens). A more detailed assessment may also be required when there is uncertainty as to the risk of exposure or health.

In order to complete a detailed assessment, further information may be sought and decisions taken to:

- eliminate the uncertainty of any risks
- select appropriate control measures
- ensure that control measures are properly used and maintained, and
- determine if air monitoring or health monitoring are required.

It may be necessary to engage external professional assistance to undertake a more detailed assessment.

Structuring risk assessments

Risk assessments can be simplified by evaluating the nature of the work in smaller, more manageable parts. You do not need to do a risk assessment covering each work activity in the whole workplace. Instead, evaluate the nature of the work by:

- **Dividing up the workplace**—If it is not practicable for the workplace to be assessed as a whole, divide it into smaller units (locations/areas or processes) to make risk assessment more manageable. Walking through the workplace and looking at floor plans or process plans will help you decide how to divide up the workplace.
- **Grouping similar work**—Workers performing similar work or using similar substances may be grouped together if it has been established that their exposures are representative of their group. They are referred to as ‘similarly exposed groups’. In doing this you can avoid having to repeat exposure assessments for each and every worker.
- **Grouping similar chemicals**—If the work involves a large number of different hazardous chemicals, they may be grouped on the basis of their form, properties and the way they are used or handled. This kind of grouping may be appropriate for example, where:
    - a range of solvent-based paints containing a number of different solvents and additives are used in the same or similar way (for example, sprayed, brushed or applied with a roller)
    - solvent-based liquid pesticides are used in the same or similar way (for example, decanted, mixed or sprayed).

- **Examining work practices and conditions**—Once you have divided the workplace into manageable units, you should observe and consult with workers to find out how the job is actually done. Workers may sometimes not adhere strictly to standard operating procedures for certain tasks. This could be because they have devised a more efficient and/or safer method for performing that task, or because the control measures or personal protective equipment (PPE) provided make it cumbersome and difficult. Workers should be encouraged to share their views and concerns on working practices and be involved in discussions on how to improve working methods. Also, it is good practice to find out what changes in workplace activities occur during cleaning, maintenance, breakdowns and during staff absences or shortages.
- **Sourcing other information**—You should take account of any information about incidents, fires, spills, illnesses or diseases that may be related to the use of the hazardous chemical. Check your accident/incident records. Ask those doing the work if they have experienced symptoms listed on the SDS. This information will help you to determine if exposure has been significant.

Considering both health and physical risks

Hazardous chemicals may present an immediate or long-term risk to human health through their toxicological properties (**health hazards**), or a risk to safety of persons and property as a result of their **physical hazards**. In some cases, chemicals may present both health and physical hazards, for example solvents such as benzene, toluene and xylene.

There are many common elements to assessing risks from health and physical hazards, but also several key differences in the way these risks are assessed. As a consequence, the assessment of health and physical risks are discussed separately in this chapter.

3.3 How to assess health risks

The assessment of health risks from hazardous chemicals involves gaining an understanding of the situations where people can be exposed to, or come into contact with the chemicals, including the extent of exposure and how often this can occur. Health risk depends on hazard severity and level of exposure and thus depends on both the type of chemical and the nature of the work itself.

As with all risk assessments, the assessment of chemical hazards needs to consider all workers potentially at risk, including those not directly involved in a work activity, as well as other people such as visitors to the workplace.

Determining hazard severity

The type and severity of the hazards of the chemical (for example, hazard classifications of carcinogenicity, sensitisation, acute toxicity) should be known from the hazard identification step (see Chapter 2). This information is needed in the risk assessment to understand the level of risk based on the likely or potential exposures in your workplace.

The Code of Practice *How to manage work health and safety risks* contains more information to help work out how severe the harm could be.

Determining the level of exposure

The level of exposure to a hazardous chemical will determine the likelihood of harm occurring. The Code of Practice *How to manage work health and safety risks* contains questions to help work out the likelihood of harm occurring.

You should consider the following factors in assessing the likelihood of harm.

The physical form and concentration

Some substances may be harmless in some forms (such as a block of metal, a piece of wood or solid chemicals) but may be very hazardous in another form (such as fine dust particles generated when processing wood or metal fumes from welding that can be readily inhaled, or solutions that may be splashed and readily absorbed through skin). This is also an important consideration in assessing risks from physical hazards.

The concentration of hazardous ingredients is also an important factor in the overall risk. Concentrates or pure substances may be extremely hazardous, while dilute solutions of the same chemical may not be hazardous at all. Information on the form and concentration of a chemical can be found in the SDS.

The routes of entry by which the chemical can affect your health

The relevant routes of exposure (for example, inhalation, ingestion, skin contact) should be known from the hazard identification step (see Chapter 2). This information is needed in the risk assessment to understand the level of risk from the likely or potential exposure in your workplace.

For particulates in air, the primary health concern is effects on the lungs due to inhalation exposure. For example, crystalline silica is considered hazardous principally because of the long-term, irreversible lung effects (such as silicosis) that may arise from prolonged or repeated exposure to, or exposure to high concentrations of, silica dust. Its hazardous properties are associated with inhalation, so the evaluation of risk should be based on the potential for breathing in the crystalline silica dust rather than other routes of exposure (for example, contact with the skin). In the case of crystalline silica, it is the respirable fraction of the dust that presents the greatest risk to workers as this fraction contains the smallest particles which can reach further into the lungs causing the most damage.

In contrast, even brief exposures to high concentrations of sodium hydroxide (caustic soda) may lead to immediate effects which include irritation and burning of the skin, eyes and respiratory tract and blindness. Its hazardous properties relate to exposure via skin or eye contact and inhalation. Evaluation of risks to health for sodium hydroxide should therefore consider the potential exposure through all of these routes.

The chemical and physical properties of the substance

Gases or liquids with low boiling points or high vapour pressures can give rise to high airborne concentrations in most circumstances, whereas high boiling point liquids such as oils are only likely to create a hazardous airborne concentration if they are heated or sprayed. Chemicals with a very low or high pH (for instance, strong acids and caustics respectively) are corrosive to the skin and eyes. The size of dusts and fibres can affect their health risk, because very fine particles can be breathed deeper into the lower lungs.

Many substances have a distinctive odour which indicates the presence of the substance in the workplace, but this cannot be relied upon as an indicator of exposure risk. The use of odour thresholds is not reliable because the presence or absence of an odour is not related to a substance's harmful effects which may occur at exposure levels far below the odour threshold. The absence of an odour does not indicate a 'safe' workplace.

The chemical and physical properties of a substance are also important in assessing risks from physical hazards, described in Section 3.4: How to assess physical risks.

Determining who could be exposed, and when this could occur

Workers can come in contact with a hazardous chemical and any waste, intermediate or product generated from the use of the substance if they:

- work with it directly
- are in the vicinity of where it is used or likely to be generated
- enter an enclosed space where it might be present
- disturb deposits of the substance on surfaces (for example, during cleaning) and make them airborne, and/or
- come into contact with contaminated surfaces.

You should consider all people at the workplace, including those who may not be directly involved in using, handling, storing or generating a hazardous chemical, such as:

- ancillary or support/services workers (be aware that cleaners, maintenance and laboratory staff are often exposed to both the hazardous chemicals they use in the course of their work, such as cleaning products, and the hazardous chemicals used in the workplace by other workers)
- contractors
- visitors, and
- supervisors and managers.

Different tasks will produce different levels of exposure. You should consider:

- how specific tasks or processes are actually carried out in the workplace (for example, decanting, spraying, heating). By observing and consulting workers you can find out if they are not adhering strictly to standard procedures or if procedures are not adequately providing protection to workers
- the quantity of the chemicals being used. Use of larger quantities could result in greater potential for exposure
- the risk controls in place and their effectiveness. For example, a ventilation system may be in use but when poorly designed, installed or maintained it may not achieve the correct level of protection (such as if filters are not regularly cleaned)
- whether each worker's work technique has a significant bearing on their level of exposure—poor techniques can lead to greater exposure, and
- workers who may be working alone with hazardous chemicals and if any additional precautions or checks may be necessary in case they become incapacitated.

How often is exposure likely to occur and for how long?

The total dose (amount) of a hazardous chemical a worker is likely to receive increases with an increase in the duration or frequency of exposure. Estimations of the duration and frequency of exposure can be based on observation, knowledge and experience of the work. Seek information from your workers and their health and safety representatives to find out:

- Which work activities involve routine and frequent exposure to hazardous chemicals (for example, daily exposure, including during end-of-shift cleaning) and who are the people performing these activities?
- What happens when non-routine work, production of one-off items or isolated batches, trials, maintenance or repair operations are performed?
- What happens when there are changes to work practices in events such as cleaning, breakdowns, changes in volume of production, adverse weather conditions?
- Are there differences between workers within a group? Anyone whose work habits or personal hygiene (for example, washing before eating, drinking or smoking) are significantly different should be considered separately.

Estimating the risk of exposure to hazardous chemicals

Once you have investigated the hazardous chemicals, the following information should then be used to estimate the level of exposure:

- the quantities used
- the frequency and duration of exposure
- the effectiveness of the controls already in place, and
- whether workers are working directly with the substance.

To estimate the risk of exposure or harm from the exposure, you should consider the level of exposure and the severity of the consequences. Information on determining these two factors can be found in the Code of Practice *How to manage work health and safety risks*.

If you are having difficulty determining the risk to health from exposure to a chemical, you should engage a suitably qualified person, like an occupational hygienist, to assist.

Complying with exposure limits

WHS Regulation 49

Ensuring exposure limits for substances and mixtures not exceeded

As described in Section 1.5 of this Code, you must ensure that no person at the workplace is exposed to a substance or mixture in an airborne concentration that exceeds the exposure limit for the substance or mixture.

Air monitoring may be necessary to ensure that workers are not exposed to airborne concentrations above the chemical's exposure limit. Air monitoring is best done after risk assessment and after control measures have been put in place.

The *Guide for PCBUs: Air monitoring and workplace exposure limits for airborne contaminants* contains more information on determining when air monitoring is required.

Compliance with Regulation 49 requires determination of a person's exposure, which can take into account the protection provided by RPE, provided certain conditions are met. This includes that RPE can only be used to minimise risks after all other reasonably practicable higher order controls in the hierarchy of control measures have been implemented and that RPE must be worn correctly.

There are factors that can affect the level of workers' exposure or the overall health effect that occurs because of exposure, which need to be considered in assessing workers' health risk, such as the risks of skin absorption, sensitisation and ototoxic effects. If any of these factors apply, the exposure limit may not be protective of all workers and additional controls may be required.

For example, sensitisers such as isocyanates, can induce an adverse reaction in workers at levels well below the exposure limit once sensitisation has occurred. If a worker becomes sensitised to a chemical, the exposure limit for that chemical is no longer relevant and additional control measures, such as improving engineering controls or job rotation to remove the affected worker from potential exposure to the chemical, should be implemented. Where results of monitoring show concentrations of airborne contaminants approaching the exposure limit (for example reaching greater than half of the limit – often known as the action level), you should review your control measures. Even if monitoring indicates that exposure is below an exposure limit, sensitive workers may still be at risk. Exposure limits do not represent a 'no-effect' level which makes exposure at that level safe for all workers, therefore you should ensure that exposure to any hazardous chemical is kept as low as reasonably practicable. This includes exposure to hazardous chemicals that do not have exposure limits, as they may still pose a risk to workers.

Biological monitoring may be a helpful means of assessing a worker's overall exposure to a hazardous chemical that can be ingested or absorbed through the skin as well as inhaled. Further information on biological monitoring is available in the guidance material for health monitoring.

For more information on how to interpret exposure limits and comply with the WHS Regulations, refer to Safe Work Australia's:

- *Workplace exposure limits for airborne contaminants*
- *Guide for PCBUs: Air monitoring and workplace exposure limits for airborne contaminants*, and
- *Technical guide: Air monitoring and workplace exposure limits for airborne contaminants.*

3.4 How to assess physical risks

The assessment of physical risks in the workplace is different in many respects from that needed when assessing health risks. Whereas health risks arise from interaction of people with the chemical, physical risks arise mainly from hazardous chemicals where they come into contact with other things such as ignition sources.

Fire and explosion

WHS Regulations Part 3.2: Division 8

Hazardous atmospheres

As a PCBU, you must manage the risk to health and safety associated with a hazardous atmosphere or an ignition source in a hazardous atmosphere at the workplace.

Fire and explosion can result in catastrophic consequences, causing serious injuries or death of workers, as well as significant damage to property. They occur when the following three primary elements come together (commonly referred to as the fire triangle—see Figure 1):

- a source of fuel (a flammable or combustible substance)
- a source of oxygen (usually in the air), and
- an ignition source (a source of energy sufficient to cause ignition).

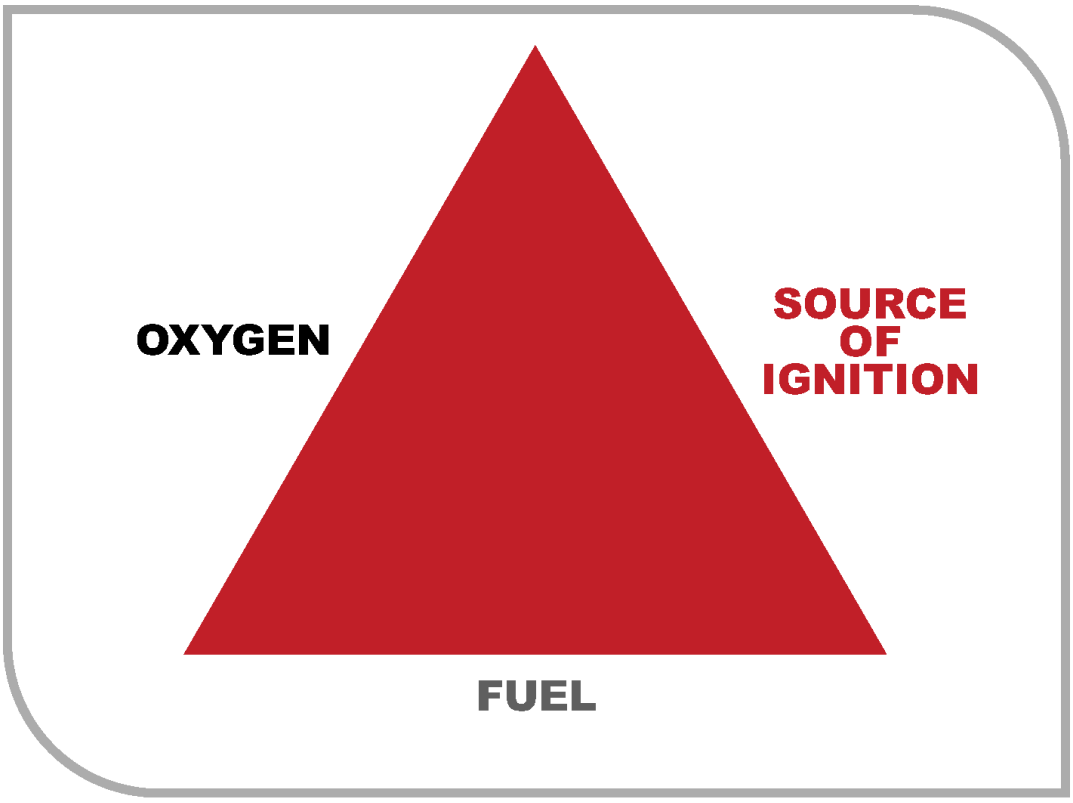


Figure 1: Fire triangle

When identifying hazards you should have identified all of the sources of fuel in your workplace that could contribute to fire and explosion risks. Fuels that present the highest risk are:

- those hazardous chemicals that are flammable (for example, flammable solids, liquids or gases, including their vapours and fumes)
- other fire-risk substances in other hazard classes (for example, pyrophoric solids, liquids and gases that ignite spontaneously in contact with air, substances that react with water to emit flammable gases), and

- other materials that are not hazardous chemicals, like wood, paper and leaves, and other combustible materials that contribute to the fire load.

You should also identify sources of oxygen, such as oxygen gas and compressed air in cylinders, chemical oxidisers and peroxides. Oxygen is always present in the air.

Note: Chemical reactions and other processes which generate gases can also cause explosions through an increase in the pressure in the container in which the chemical is stored if the gas cannot escape, even if that gas does not itself ignite.

Identifying ignition sources

Ignition sources can be any energy source that has the potential to ignite a fuel. They can be categorised into three broad types: flames, sparks and heat. Some common examples of ignition sources are provided in Table 3.

Table 3 Common examples of ignition sources

Type of ignition source	Examples
Flames	• Welding flames, gas heaters, pilot lights
Sparks	• Welding arcs, starters for fluorescent lighting, electric motors, electrical equipment like power points, cigarette lighters, switches and telephones • Static electricity including from friction sources • Lightning • Friction from drilling, grinding, scraping of metal on concrete
Heat	• Hot surfaces including light bulbs, ovens, radiators or heaters, flue pipes, vehicle engines and exhaust systems, pumps and generators • Exothermic chemical reactions (those which generate heat)

Some electrical equipment may also be a source of ignition. However, not all electrical equipment is an ignition source if it is specifically designed so that it does not create sparks. This type of equipment is referred to as ‘intrinsically safe’.

You must identify any ignition source in your workplace that has the potential to ignite flammable or combustible material. You should also consider sources of ignition that are adjacent to your workplace or may periodically come into your workplace, for example delivery vehicles (with hot engine and exhaust systems), visitors, or portable items like cordless power tools, radios and fans.

Other factors affecting fire and explosion risks

The following physical and chemical characteristics of materials can influence the level of risk of a fire or explosion occurring.

Form and physical state

The form or physical state of chemicals, substances or other materials can have a significant influence on the level of risk of a fire or explosion. The physical state of a material is generally considered as being solid, liquid or gas. However, materials can be further categorised as aerosolised droplets, vapours, fumes, mists, powders, dusts or fibres.

Bulk materials in solid, liquid and gas forms behave differently and present different risks. Liquids spread readily compared to solids and have a greater risk of coming into contact with an ignition source if spilled. Gases present a greater risk as concentrations in air are generally higher than for liquids (and their vapours) and can spread more rapidly. Depending on the vapour density, some gases can flow across surfaces in a similar way to liquids, rather than dissipating quickly. For example, vapours which have a density greater than air can move along the floor and spread to adjacent work areas where ignition sources may be present, thereby creating a significant risk in those areas.

Temperature and pressure

Changes in temperature and pressure can affect the properties of a chemical.

The explosive range of a chemical (for instance, its lower and upper explosive limits) can change with temperature. At higher temperatures, the lower explosive limit is usually lower, meaning that the substance is more likely to ignite at lower concentrations in air. Heating solid or liquid combustible substances can also increase the vapour pressure (for instance, the concentration of vapours emitted) of the substance making it more likely to ignite.

Handling chemicals under pressure increases the risk in several ways. Any loss of containment will occur more rapidly than under normal atmospheric pressure so that more hazardous chemical is released. Increasing pressure generally increases the temperature of the material, and some chemicals also become unstable at higher temperatures and pressures causing an uncontrolled decomposition or reaction.

Confinement

The effects of an explosion can be exacerbated where the fuel and air mixture is contained, for example in a tank, duct or pipework, as well as in larger structures like silos, rooms or buildings. Explosions can be more violent than when unconfined, and flying debris (such as from the container or building) can cause serious injuries or death.

Fire and explosion risks involving chemical oxidisers

Chemical oxidisers can react violently and unexpectedly with many chemicals such as organic material (for example, wood, paper, cellulose products), hydrocarbon solvents (for example, mineral turpentine, petrol, diesel) and other organic (carbon-based) chemicals (for example, ethanol, mineral oils).

You should assess any situation where an oxidiser could come into contact with these types of materials. This includes any containers and other equipment used in handling or transferring the chemicals. Oxidisers should be handled in compatible containers and with compatible equipment to avoid a dangerous reaction occurring.

It is important to note that, since oxidisers provide oxygen through the chemical reaction, rather than air being the oxygen source, a risk of fire or explosion can still exist even if these materials are handled under an inert atmosphere like nitrogen.

Fire and explosion risks from other chemical reactions

Fires and explosions can occur as a result of chemical reactions. Many chemical reactions are exothermic—that is, they give off heat during the reaction—and this heat can act as an ignition source igniting any fuels present. Pressure can build up in enclosed systems (for example, containers, flasks, pressure vessels) causing the container to rupture or even explode.

You should assess any situation where incompatible chemicals could interact and cause a dangerous or uncontrolled violent reaction.

Dust explosion risks

Dust explosions present a significant risk in some workplaces, however they are often overlooked. Dust explosions usually occur where combustible dusts (or fibres, for example from paper, grain, finely divided organic compounds and metals) have accumulated and are then disturbed and released into the air, coming into contact with an ignition source. Common ways in which dusts can be disturbed include from wind when opening doors or windows, during cleaning or sweeping up of waste or using compressed air to blow out material accumulated in crevices, gaps or in machinery.

Dusts may also be generated when transferring materials, such as filling the hold of a ship or a silo with grain (liberating grain dust).

When the dust cloud comes into contact with an ignition source such as a flame, hot surface or spark, ignition can occur causing an explosion. Dust–air mixtures can be classified as hazardous atmospheres in the same way as other flammable materials like vapours from flammable liquids and gases.

Dust clouds can also be generated when the pressure of an explosion disturbs dust accumulated in other areas. These new dust clouds may also ignite, causing further dust explosions.

Effect of particle size on dust explosion risk

The size of particles in dust can have a significant impact on the explosion risk. Smaller particles have a greater surface-to-mass ratio and present a greater risk, for example a block of metal such as a metal ingot may be practically inert but could be extremely reactive when in the form of filings or shavings, dust or powder. Similarly, the risk from an aerosol form of flammable liquid (for instance, fine droplets in air) is much greater than for the bulk liquid. Processes that generate fine particles, like grinding and milling of flour and nanomaterials can present significant risks. Special control measures may be needed for handling such materials.

The classification of dust hazardous atmospheres is complex and depends on many factors, including the rate of dust dispersion, sedimentation characteristics and particle size. Further information is contained in the following Australian Standards:

- AS/NZS 4745: Code of Practice for handling combustible dusts, and
- AS/NZS 60079.10.2: Explosive atmospheres—Classification of areas—Explosive dust atmospheres.

Off-site risks

Some activities, systems of work, structures and equipment that are not directly involved with the use, storage and handling of hazardous chemicals in the workplace may create a hazard that you need to be aware of when undertaking your risk assessment. These include:

- Hazardous chemicals on adjacent or nearby premises that could be ignited by activities at your workplace, and other substances and materials that are not hazardous chemicals but that could add to the overall fire load, such as wooden pallets, paper, combustible liquids or other combustible materials.
- Activities and installations on adjacent premises, such as the operation of plant, equipment and vehicles, deliveries of hazardous chemicals, personnel movements in normal and emergency situations, visitor access and the trial of site emergency procedures.
- The proximity of sensitive facilities which may be put at risk by the presence of hazardous chemicals and during an emergency, such as schools, hospitals, child and aged care facilities, theatres, shopping centres and residences. These may require special consideration when planning for emergencies.
- The presence of incompatible materials, either other chemicals or the materials that plant, equipment, storage and handling systems are made of which could react with the chemicals being stored or handled.
- Foreseeable failures of plant, equipment, storage systems, as well as natural disasters or extreme weather events such as temperature extremes, wind, lightning or rainfall, including the potential for flooding.
- Other failures which could occur and events which may give rise to new hazards or greater risk. Any examination should be systematic, and include consideration of the possibility of human error in the system’s operation.

Risks from corrosive substances

Hazardous chemicals that are corrosive to metals can cause damage to plant and equipment, such as containers, pipes, fixtures and fittings. Corrosion can lead to leaks or complete failure and loss of containment of the chemical, resulting in serious damage to property, exposure of workers to the hazardous chemicals and potential injury and death.

Compressed gases

Compressed and liquefied gases are used as fuel, a source of oxygen or as shielding gases in certain types of welding. The hazards associated with compressed and liquefied gases include fire, explosion, toxicity, asphyxiation, oxidation and uncontrolled release of pressure. Gas leakage is one of the greatest hazards.

Cylinders contain large volumes of gas under high pressure and precautions need to be taken when storing, handling and using cylinders.

Asphyxiation hazards

Asphyxia is a condition that occurs where there is lack of oxygen. This can occur either through:

- consumption of oxygen in the air (burning of fuel, or oxidation processes such as microbial activity or rusting)
- an accumulation of gases (called simple asphyxiants) displacing oxygen in air, or
- inhalation of a chemical (called chemical asphyxiants) affecting the ability of the body to use oxygen (for example, hydrogen cyanide can asphyxiate a person by binding to haemoglobin in the blood following inhalation).

All gases, including fuel gases (for example, hydrogen, acetylene and liquid petroleum gas) and inert gases (for example, argon, helium and nitrogen) are an asphyxiation hazard in high concentrations. Most simple asphyxiants are odourless, and oxygen-deficient atmospheres don't provide sensory warning of danger.

Too little oxygen in the air that we breathe can cause fatigue and in extreme cases death. Using compressed and liquefied gases can result in dangerously low levels of oxygen. For example, gases that are heavier than air can accumulate in low-lying areas such as pits, wells and cellars, and gases that are lighter than air can accumulate in high areas such as roof spaces and lofts. Working in an enclosed or confined space with inadequate ventilation, where hazardous vapours can accumulate, is a potential asphyxiation hazard.

You should identify possible causes of asphyxiation in your workplace. For example. in welding and allied processes, asphyxiation can occur from gas slowly leaking in a work area. If asphyxiation hazards are due to working in a confined space, see the *Code of Practice: Confined spaces* for further guidance.

Compressed air

Compressed air can be hazardous and should be handled carefully by workers. For example, the sudden release of gas can cause hearing damage or even rupture an eardrum. Compressed air can also deeply penetrate the skin, resulting in an air bubble in the blood stream known as an embolism. Even a small quantity of air or other gas in the blood can be fatal.

Ensuring workers are trained to handle compressed air properly can eliminate many of the associated risks. Training and work procedures should emphasise the safe use of air tools and safeguard against the deliberate misuse of compressed air. Also, maintaining air receivers properly prevents the potential for an explosive rupture.

4. Controlling risks

4.1 The hierarchy of control measures

There are a number of ways to control the risks associated with hazardous chemicals. Some control measures are more effective than others. Control measures can be ranked from the highest level of protection and reliability to the lowest. This ranking is known as the *hierarchy of control*.

As a person conducting a business or undertaking (PCBU), you must always aim to eliminate a hazard and associated risk first. If this is not reasonably practicable, the risk must be minimised by using one or more of the following approaches:

- substitution
- isolation
- implementing engineering controls.

If a risk then remains, it must be minimised by implementing administrative controls, so far as is reasonably practicable. Any remaining risk must be minimised with suitable personal protective equipment (PPE).

Administrative control measures and PPE do not control the hazard at the source. They rely on human behaviour and supervision and when used on their own, tend to be the least effective ways of minimising risks.



Figure 2: Hierarchy of control measures figure

Eliminating the hazard

This means removing the hazard or hazardous work practice from the workplace. This is the most effective control measure and must always be considered before other control measures. You may choose to not use a hazardous chemical (for example using nails instead of using chemical-based adhesives) or eliminate exposure (for example eliminating a handling activity and potential worker exposure by purchasing pre-mixed or diluted chemicals instead of manually mixing or diluting chemicals at the workplace).

Substitution

Substitution is the replacement of a hazardous chemical with a chemical that is less hazardous and presents lower risks, for example:

- substituting a less volatile material to control a vapour hazard (which may cost less than the installation and maintenance of a mechanical ventilation system)
- substituting a highly flammable liquid with one that is less flammable or combustible
- using hazardous chemicals with a single hazard class rather than those with multiple hazards
- substituting high hazard chemicals like carcinogens, mutagens, reproductive toxicants and sensitisers with less hazardous chemicals
- using diluted acids and alkalis rather than concentrates
- using a product in either paste or pellet form rather than as a dust or powder.

Note: The elimination and substitution of hazardous chemicals can be supported by implementing a purchasing policy that promotes the purchase of non-hazardous and less hazardous chemicals.

Isolation

Isolation involves separating people from the chemicals or hazards by distance or barriers to prevent or minimise exposure. Examples of isolation include isolating workers from chemicals, and segregation of chemicals.

Isolate workers from chemicals

This can be achieved through methods such as:

- use of closed systems such as those used during the processing and transfer of flammable liquids in petroleum refineries, or the use of glove boxes or glove bags
- placing a process, or a part of it, within an enclosure which may also be fitted with exhaust extraction to remove contaminants
- isolating operations in one room with access restricted to properly protected personnel
- placing operators in a positive pressure cabin that prevents airborne contaminants entering
- distancing workers from hazardous chemicals and any potential hazards generated by their use.

Isolate chemicals from other chemicals (segregation of chemicals)

Hazardous chemicals should be physically separated from any chemicals or other things that may be incompatible. This is achieved by distance, barriers, or a combination of both barriers and distance.

Isolation as a control measure is usually used to control physical hazards because of the greater consequences when incompatible materials interact. However, it is also important to consider isolation from other hazardous chemicals. The choice of isolation measure used will depend on a range of factors, including:

- the quantity of hazardous chemicals stored and handled in the work area
- the type of installation involved, and the processes applied to the hazardous chemicals in the work area and their associated hazards
- all other activities in the work area which may increase the risks, and
- any other control measures in place that will minimise the risks.

If possible, separation distances should be applied in a way that would not require additional control measures. If this is not possible, barriers may be required.

When choosing to use a barrier, you should consider:

- the effect that climatic elements may have on a barrier and its effectiveness
- the level of fire resistance provided by the barrier
- the structural capability which may be required to withstand weather, and
- overpressure resulting from internal or external incidents.

When storing chemicals on shelving or other storage systems, hazardous chemicals should not be stored above or below other chemicals or other things which may be incompatible, potentially interact or contaminate. Hazardous chemicals should never be stored where they could contaminate food, food packaging and other items like personal use products, cosmetics, cigarettes, medication and toiletries.

Information on safely storing and segregating flammable liquids is available in AS 1940: *The storage and handling of flammable and combustible liquids*.

Engineering controls

Engineering controls are physical in nature, including mechanical devices or processes that eliminate or minimise the generation of chemicals, suppress or contain chemicals, or limit the area of contamination in the event of spills and leaks. They often involve partial enclosure, use of exhaust ventilation or automation of processes. Examples of engineering controls include:

- using intrinsically safe electrical equipment in hazardous areas
- using robots to minimise operator exposure, for example, spraying in coating operations
- partially enclosed and ventilated spray booths or fume cupboards
- fully enclosed ventilation booths (see diagram 1 in Figure 3 below), or
- local exhaust ventilation to capture airborne contaminants close to their point of release (see diagrams 2 and 3 in Figure 3 below).

Ventilation

Ventilation is a major engineering control. Correct design is essential to ensure that ventilation is effective. There are a range of different ventilation systems, and the most appropriate form needs to be used.

Design considerations for ventilation systems

Ventilation is a means of maintaining a safe atmosphere by the introduction or recirculation of air; by natural, forced or mechanical means. Maintaining a safe atmosphere in the storage and handling area of hazardous chemicals is an important control measure. Recirculation should be avoided unless precautions are taken to detect and avoid harmful contamination, and prevent accumulation of airborne contaminants. Recirculation should only be used where temperature control is required.

A ventilation system should operate exclusively for the particular building, room or space. Where this is not practicable, the system may be linked to another area provided that this does not increase the risk to exposure of hazardous chemicals, for example by recirculating hazardous or flammable vapours or spreading them into other areas where that chemical is not being used.

Ventilation systems should be suitable for the types of hazardous chemicals on the premises. For example, if a hazardous chemical has vapours which are denser than air, these will accumulate in low-lying areas. In this case, extraction of vapours should be from the lowest point and fresh air introduced from above.

Exhaust systems and ducting should be resistant to the vapours, mists or dusts being extracted. The risk of fire propagation can be reduced by installing self-closing fire dampers, for example in laboratory fume cupboards. Extraction ducting should not be linked to multiple items of plant if there is any risk of fire spreading through the ducting. Provision against flashback, for example by installing flame arresters, may be necessary.

Exhaust gases and air should be discharged where they will not cause other hazards. For example, fume cupboard extraction systems should not exhaust close to air intakes and should be in compliance with any local building or environmental protection requirements. Exhaust systems can also be fitted with means to reduce airborne contaminants which may be harmful to the environment or people prior to discharge to the atmosphere. This might include particulate filters, absorbents and adsorbents (for example carbon), catalysts, scrubbers or burners.

Regular checks of these systems should be included in planned maintenance schedules to ensure that vents remain unobstructed.

To ensure the effectiveness of ventilation systems, they should be designed in accordance with appropriate technical standards, and installed and maintained by qualified or experienced persons, such as engineers or occupational hygienists.

Further information on the design of ventilation systems can be found in:

- AS 1940: The storage and handling of flammable and combustible liquids
- AS/NZS 60079.10.1: Explosive atmospheres—Classification of areas—Explosive gas atmospheres [IEC 60079-10-1, Ed 1.0 MOD]
- HSG258 Controlling airborne contaminants at work: A guide to local exhaust ventilation (LEV), 3rd edition 2017, Health and Safety Executive (UK), and
- *Industrial Ventilation: A Manual of Recommended Practice for Design*, 31st edition, American Conference of Governmental Industrial Hygienists (ACGIH).

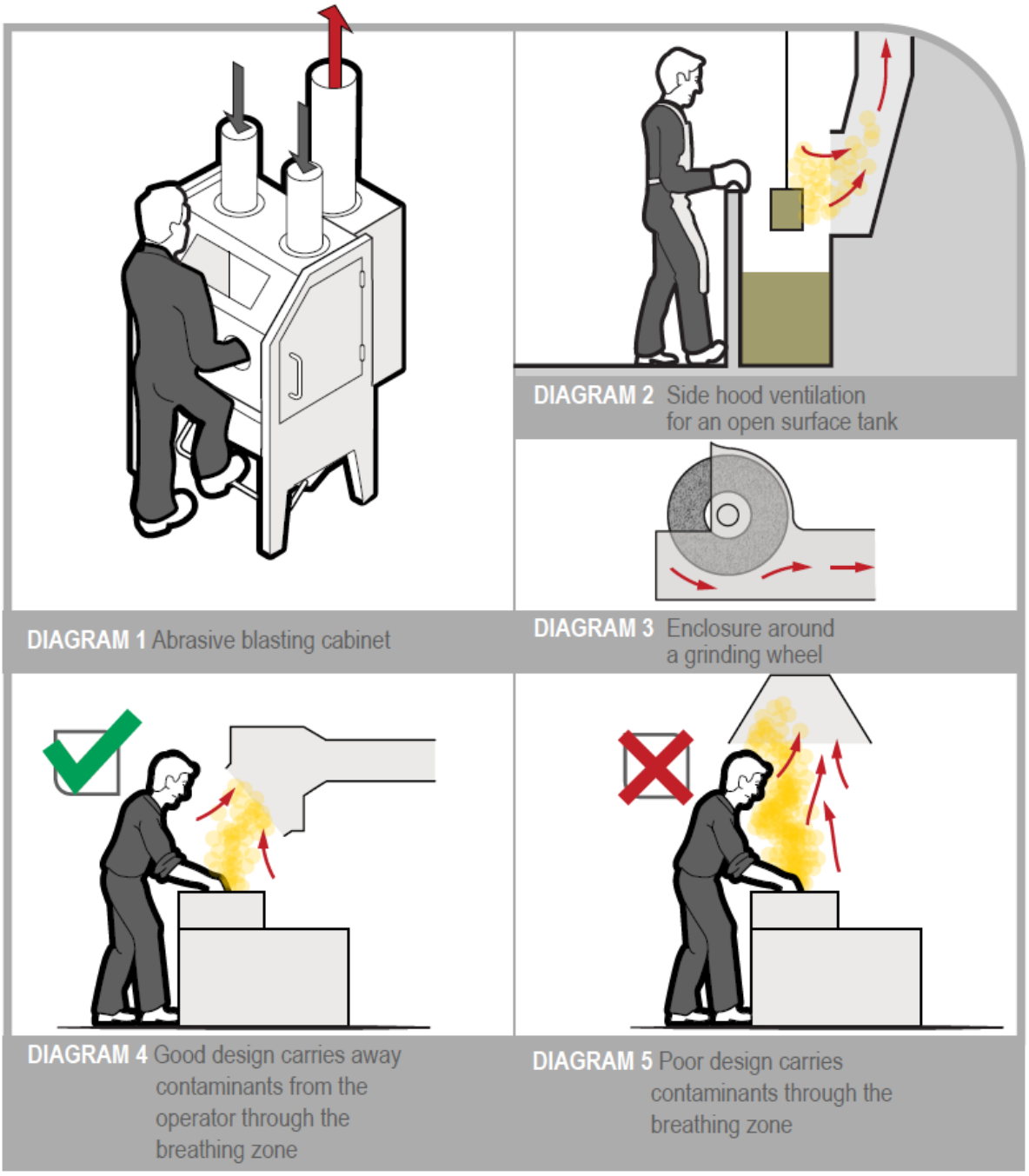


Figure 3: Diagram 1 shows an abrasive blasting cabinet; Diagram 2 shows side hood ventilation for an open surface tank; Diagram 3 shows an enclosure around a grinding wheel; Diagram 4 shows good design carrying away contaminants from the operator's breathing zone; Diagram 5 shows poor design carrying contaminants through the operator's breathing zone

Mechanical ventilation

Inlet and outlet vents located on opposite sides of the storage area at low levels provide airflow across the floor. Where both inlet and outlet are mechanically assisted, capacities and rates should be adjusted to ensure that the pressure inside the store or room never exceeds that outside and airflow into any adjoining work areas and offices is prevented.

Local exhaust ventilation

Local exhaust ventilation is used to remove airborne contaminants before they reach the breathing zone of workers in the area. It is used for effective control of more highly toxic contaminants created in large quantities and is applied close to the source of generation. It is more effective than increasing general ventilation to try to dilute toxic contaminants.

Local exhaust ventilation is designed to capture airborne contaminants close to the source of generation. This prevents them from contaminating the working environment. The ventilation should be arranged to prevent contaminants from entering the breathing zone of the operator. In Figure 3, the exhaust extraction shown in diagram 4 is well-designed, while that shown in diagram 5 is poorly designed as it carries contaminants directly through a person's breathing zone.

Natural ventilation

Natural ventilation can be used to control small amounts of relatively low toxicity contaminants including dusts, fumes, gases and vapours which have low and steady rates of generation. It requires a large building space for dilution and relatively large capacity for airflow through open doors, windows or ceiling exits. For solvent storage or handling areas, where vapours heavier than air may accumulate in lower regions (for example, near floor level) with a subsequent build-up of hazardous concentrations, vents should be provided at a level immediately above any spill containment, on the opposite sides of the room or space, to provide for airflow across the area. High level ventilation may also be necessary for temperature control (for example, roof vents to allow the escape of warm air).

As natural ventilation does not capture or filter out airborne contaminants it should not be used where it may cause a hazard in surrounding areas, for example when high levels of chemicals are present and would accumulate outside.

Note: Vents in a screen wall may negate any fire protection or vapour barriers.

Administrative controls

Administrative controls should only be considered when other higher order control measures are not practicable, or to supplement other control measures. For carcinogens, administrative controls should only be used to provide additional protection.

Administrative controls should also be considered for emergencies when other control measures fail, such as for managing spills and leaks, and are particularly important for those workers who are required to clean up spills, or who carry out regular cleaning and maintenance work. Examples of administrative controls include:

Warning and access controls

- Signs in an area identifying it as a place where hazardous chemicals are used or stored
- Labels on hazardous chemicals
- Signs that alert workers to other controls in use, particularly where they may have to take an action to ensure controls are effective (e.g. closing doors, turning on ventilation).
- Swipe or access cards, security personnel or a log book system to access places where hazardous chemicals are used or stored.

Processes and systems of work

- Written rules and policies for using, handling or storing hazardous chemicals—for example, having a written clean-up procedure for spills
- Implementing procedures to prevent introduction of ignition sources in hazardous areas
- Requiring staff to use vacuuming or wet sweeping methods to avoid dust that may be generated during dry sweeping
- Prohibiting eating, drinking and smoking in areas where hazardous chemicals are used, stored or handled
- Providing washing facilities for rinsing off chemicals (such as hand washing, showers, laundering of clothes)

Reducing periods of exposure

- A job rotation schedule—so that the same workers are not continually exposed to chemicals with chronic health effects
- Restricted area policies—so that only staff who are involved in the use, handling, storage or generation of hazardous chemicals are allowed access to high risk areas where there may be a greater risk of exposure
- A purchasing policy—this may include just-in-time ordering so that large quantities of chemical do not need to be stored on site, or preferential purchasing of premixed chemicals so that workers do not need to manually mix hazardous chemicals
- Using a work method that minimises the time that mixers, reactors or ovens are open to the environment (both during and after use)—this limits the period of time in which a chemical could escape into the work area

Maintenance and housekeeping

- Having a cleaning schedule for work areas and a maintenance schedule for engineered controls

Information, training, instruction and supervision

Training and supervision must be provided to ensure administrative controls are implemented effectively.

The information, training and instruction should enable workers to recognise where risks may not be effectively managed, such as obvious deterioration in the controls used (like poor maintenance of engines, damage to extraction equipment or ineffective ventilation), so they can report to the people who would then take the necessary action to rectify the situation.

Information, training and instruction should include the following:

- the hazards and risks to the worker
- the control measures implemented, how to use and maintain them correctly, for example how and when to clean or replace filters
- arrangements for reporting any changes in the workplace
- the arrangements in place to deal with emergencies, and
- the selection, use, maintenance and storage of any personal protection equipment (PPE) required to control risks and the limitations of the PPE.

Information, training and instruction must be provided in a way that it is easily understood. The amount of detail and extent of training will depend on the nature of the hazards and the complexity of the work procedures and control measures required to minimise the risks. Records of training provided to workers should be kept.

Supervision should be provided to ensure safety procedures are being followed, particularly where administrative control measures are used to minimise remaining risks.

Personal protective equipment

WHS Regulation 44

Provision to workers and use of personal protective equipment

Personal protective equipment (PPE) is anything used or worn by a person to protect against risks to the person's health and safety. PPE includes overalls, aprons, footwear, gloves, chemical resistant glasses, face shields, respirators and air-supplied respiratory equipment.

In most circumstances, PPE should not be relied on as a control measure on its own. It should be used only as a last resort when all other reasonably practicable control measures have been used to minimise risks and a risk still remains. There may be circumstances where it is appropriate to use as interim protection until higher level controls are implemented.

If PPE is to be used at the workplace, you must ensure that the equipment is:

- selected to minimise risk to health and safety, including by ensuring that the equipment is suitable for the nature of the work and any hazard associated with the work and is of suitable size and fit and reasonably comfortable for the worker who is to use or wear it,
- maintained, repaired and replaced so that is continues to minimise risk to the worker who uses it, including by ensuring that the equipment is clean and hygienic, and in good working order, and
- used or worn by the worker, so far as is reasonably practicable.

If you direct the carrying out of work, you must provide the worker with information, training and instruction in the proper use and wearing of PPE, and the storage and maintenance of PPE.

A worker must, so far as reasonably able, use or wear the PPE in accordance with any information, training or reasonable instruction and must not intentionally misuse or damage the equipment.

For some high risk activities, such as spray-painting, abrasive blasting and some emergency response actions, PPE should always be used to supplement higher level control measures.

The effectiveness of PPE relies heavily on workers following instructions and procedures correctly, as well as fit, maintenance, and cleaning. Workers might avoid using PPE if it must be used for long periods, if dexterity and clear vision are needed for the task, or if they have not been adequately trained on how to fit and use it properly.

The best way to determine this is to observe workers performing the task. If they discard the PPE or do not use it, this may indicate that it does not fit, is uncomfortable or is a hindrance to the work. You should also observe workers after the task is complete to ensure that the PPE they have used is stored and maintained correctly.

PPE must be suitable for the task being performed. Examples include:

- Choosing appropriate chemical-resistant gloves, offering the best resistance to the chemical being used. Some gloves may be resistant to some solvents but not to others.
- Using a full-face, air-fed respirator rather than a half-face respirator during spray-painting operations to reduce exposure to hazardous chemicals like isocyanates, which can cause skin and respiratory allergic reactions.

Respiratory Protective Equipment

Respiratory Protective Equipment (RPE) is a type of PPE that is designed to protect the wearer from inhaling airborne hazardous chemicals.

Where a worker is still at risk of harm from exposure to hazardous chemicals after the implementation of higher order control measures, you must provide the worker with RPE. You must also ensure, so far as is reasonably practicable, that your workers wear the RPE they have been issued while the work is carried out.

There may be some cases where implementing higher order control measures is not reasonably practicable. In these cases, it may be appropriate for RPE to be the only control used, provided you are fulfilling your primary duty to minimise risks so far as is reasonably practicable.

When determining suitability, the protection factor assigned to the RPE must be sufficient to provide protection from the risk of inhaling the hazardous chemical. The RPE filtration must also be suitable for the hazard that is being used to control (i.e. a particulate filter or a filter for a specific gas or vapour).

Any RPE used in minimising exposure to respirable crystalline silica (RCS) generated when working with a crystalline silica substance must comply with the following Australian standards:

- AS/NZS 1716:2012 (Respiratory protective devices), and
- AS/NZS 1715:2009 (Selection, use and maintenance of respiratory protective equipment).

For all other hazardous chemicals, any RPE used to minimise exposure should comply with AS/NZS 1716:2012 and AS/NZS 1715:2009. RPE design compliance should be indicated on the product, or its packaging, by a standards mark.

4.2 For more information on managing the risks of respirable crystalline silica refer to model Code of Practice: Managing risks of respirable crystalline silica in the workplace. Specific control measures

This section includes information on key control measures that should be considered when managing risks from hazardous chemicals in the workplace. The information provided here is general in nature and aims to provide an understanding of the principles involved in managing the risks.

Information on control of risks may be included on SDS and labels. Table 4 shows some examples.

Table 4 Examples of information on control of risks

Type of information on SDS and labels	Specific control measures included
Instructions on use	Some products may have defined uses, e.g. agricultural and veterinary chemicals, and some consumer chemicals. It may be illegal to use some chemicals contrary to label directions.
Instructions on storage	This may include advice on not to store with certain incompatible materials, or advice on potential hazardous degradation products. Examples include—storage of acids and bases; storage instructions to avoid formation of explosive peroxides in ether during extended storage.
Personal protective equipment (PPE)	This may include specific types of PPE to be used, e.g. use of nitrile gloves to protect from exposure to hydrocarbon solvents; use of a specific type of respiratory protection.

Labels provide precautionary statements such as:

- Use explosion proof electrical equipment

- Use only outdoors or in a well ventilated area.

Appendix D contains specific information on managing risks in particular situations or for particular types of hazardous chemicals.

Fire and explosion risks

WHS Regulation 355

Specific control—fire and explosion

As a PCBU you must, if there is a possibility of fire or explosion in a hazardous area being caused by an ignition source being introduced into the area, ensure the ignition source is not introduced into the area (from outside or within the space).

Section 3.4 of this Code identified the factors that should be considered when assessing risks from fire and explosion. Key control measures for managing these risks include:

- designing buildings and plant to relieve and redirect pressure and flame in the event that an explosion occurs
- installing systems to detect leaks of flammable gases or vapours
- using intrinsically safe equipment
- installing ventilation to avoid creation of a hazardous atmosphere
- substituting flammable materials for ones that are less flammable or combustible
- ensuring incompatible materials are separated or segregated
- reducing quantities of flammable and combustible materials, including items that contribute to the fire load but that are not hazardous chemicals themselves (for example, wooden pallets)
- eliminating ignition sources from hazardous areas (this may include establishing a hot work permit system, detailed below)
- ensuring equipment used in handling hazardous chemicals is maintained in accordance with the manufacturer's instructions, and
- cleaning to minimise accumulation of combustible dusts.

Hot work

Hot work is any process involving grinding, welding, brazing, oxycutting, heat treatment or any other similar process that generates heat or continuous streams of sparks. Undertaking hot work in areas where flammable or combustible chemicals or other materials are present creates a significant risk of fire or explosion. Conducting hot work on containers such as drums, tanks and pipes that have not been properly decontaminated is a common ignition scenario resulting in fatalities. A hot work permit system is a system designed to eliminate or minimise risks from these activities, by controlling when and how hot work is undertaken in these areas.

Further information on hot work permit systems is available in the following Australian Standards:

- AS 1940: The storage and handling of flammable and combustible liquids
- AS 2865: Confined spaces: Appendix F, and
- AS 1674.1: Safety in welding and allied processes—Fire precautions.

Oxidising agents can contribute to fire and explosion risks. Information on working with oxidising agents can be found in AS 4326: *The storage and handling of oxidising agents.*

Eliminating ignition sources

Some common ignition sources are included in Table 3 of Section 3.4 of this Code. Ignition sources must be eliminated from any hazardous areas. This may be achieved by:

- use of intrinsically safe electrical equipment (which will not act as an ignition source). Consider whether the hazardous chemicals can generate flammable or explosive atmospheres, and ensure that any equipment being used, like stirrers, is intrinsically safe
- ensuring electrical equipment is effectively maintained. Poorly maintained electrical equipment can present a significant risk (for example, through worn brushes)
- ensuring electrical equipment is properly earthed, and
- implementing administrative controls such as permit systems preventing hot work (for example, welding) in these areas.

Static electricity can be created from a range of activities including the transfer of hazardous chemicals. Information on control of static electricity can be found in AS 1020: *The control of undesirable static electricity.*

The auto-ignition temperature of the hazardous chemical should be considered as some hazardous chemicals may ignite spontaneously above certain temperatures.

The WHS Regulations define a hazardous area as an area in which:

- an explosible gas is present in the atmosphere in quantity that requires special precautions to be taken for the construction, installation and use of plant, or
- a combustible dust is present or could reasonably be expected to be present in the atmosphere in a quantity that requires special precautions to be taken for the construction, installation and use of plant.

Hazardous areas generally exist around flammable or combustible materials, for example, those present in tanks, drums or containers.

Further information on hazardous areas can be obtained from the following Australian Standards:

- AS/NZS 60079.10.1: Explosive atmospheres—Classification of areas—Explosive gas atmospheres (IEC 60079-10-1, Ed.1.0 MOD)
- AS/NZS 60079.10.2: Explosive atmospheres—Classification of areas—Combustible dust atmospheres.

Reducing vapour emissions

Accumulation of vapours creates the potential for a hazardous area to exist. Vapour emissions resulting from transfer can be minimised by:

- the use of enclosed transfer systems and vapour recovery connections
- keeping lids open only for the minimum period required for transfer
- minimising exposed surface areas
- avoidance of splash filling
- minimising the temperature of liquids being transferred, and
- providing extraction ventilation for all sources of vapour.

When heated, the vapour pressure of flammable and combustible materials may increase, resulting in higher vapour emissions. Containers of hazardous chemicals should therefore be stored away from sources of heat (for example heaters or other heating appliances). Heat may also deteriorate packaging and increase the risk of failure of the container.

Keeping hazardous chemicals stable

WHS Regulation 356

Keeping hazardous chemicals stable

As a PCBU, you must ensure, so far as is reasonably practicable, that hazardous chemicals do not become unstable, decompose or change so as to:

- create a hazard different to the hazard originally created by the hazardous chemical, or
- significantly increase the risk associated with any hazard in relation to the hazardous chemical.

Some hazardous chemicals are inherently unstable or highly reactive, or can become unstable under certain conditions.

The WHS Regulations require that a PCBU must:

- maintain the recommended proportions of ingredients, and other components that constitute the hazardous chemicals, for example, phlegmatisers, diluents, solvents, wetting agents, desensitisers, inhibitors and/or other adulterants, and
- keep the hazardous chemicals within any control temperature range where necessary.

To keep hazardous chemicals stable, you should also follow the manufacturer's instructions or instructions on the SDS including:

- using a stabilising ingredient where appropriate, and
- keeping the hazardous chemical and the packaging dry, unless the packages themselves are impervious to moisture.

These requirements do not apply where:

- the hazardous chemical is changed or allowed to become unstable without a risk to health or safety, as part of a deliberate process or activity, or
- the hazardous chemical undergoes a chemical reaction in a manifesting process or other deliberate process.

Some hazardous chemicals may provide an expiry date on the label and SDS. Where a chemical has passed its expiry date it should not be used, but be disposed of in accordance with the manufacturer's instructions and local laws.

Impact protection—containers, structures and plant

To prevent damage from the movement of the structure or plant, including any attached pipe work or equipment, you should ensure that structures or plant used for the storage or handling of hazardous chemicals are appropriately located and fixed to stable foundations.

Measures required for preventing or controlling impact normally depend on the nature of potential risks. Impact protection measures may be necessary for:

- structures containing large quantities of hazardous chemicals
- plant and equipment including storage and process vessels, associated pipe work, pumps and controls
- storage areas (including transit storage) for packages, intermediate bulk containers (IBCs) and associated shelves and racks, and
- exposed parts of the fire protection systems.

The most effective ways to protect containers, pipe work, pumps and attachments from impact is to locate the containers away from trafficable areas or prevent vehicle access. Installation of crash protection measures, such as bollards and guardrails, is an alternative means of impact protection. These should be designed to absorb the energy of any reasonably foreseeable impact and minimise the likelihood of injury to anyone involved in the incident.

Containing spills

WHS Regulation 357

Containing and managing spills

As a PCBU you must ensure, so far as is reasonably practicable, that where there is a risk of a spill or leak of a hazardous chemical in a solid or liquid form, provision is made in each part of the workplace where the hazardous chemical is used, handled, stored or generated for a spill containment system that contains within the workplace any spill or leak of the hazardous chemical and any resulting effluent.

When a spill, leak or accidental release of hazardous chemicals occurs, appropriate actions must be taken to contain the hazardous chemicals within the workplace.

The spill containment system must describe how to contain, clean up and dispose of the spill or leak and any resulting effluent. The system must not create a hazard by bringing together different hazardous chemicals that are not compatible or that would react together to cause a fire, explosion, harmful reaction or evolution of flammable, toxic or corrosive vapour.

Leaving containers open when not in use is one of the main causes of spills and can also lead to generating hazardous atmospheres and fire risks. Procedures, training and supervision should ensure containers are sealed when not in use.

Any spill containment system should be large enough to ensure that all spills can be held safely until cleaned up. Factors you should consider when designing a spill containment system include:

- the nature of the hazardous chemicals (whether liquid or solid)
- the quantity of the hazardous chemicals
- the size of the largest container or reasonably foreseeable largest spill
- the potential impact if the hazardous chemicals escape to the environment
- whether it is necessary to provide for the management of firefighting water at an incident
- separate spill containment for incompatible goods
- the materials used to construct the containment system, as well as any materials used for absorption, are compatible with the hazardous chemicals
- other materials in the vicinity that will prevent contamination of groundwater or soil, and
- how the system's integrity will be maintained in any reasonably foreseeable incident.

For large quantities of hazardous chemicals, bunding may be required. Bunding should be designed and constructed in accordance with the relevant Australian Standard specific to the type of hazardous chemical, for example AS 1940*: The storage and handling of flammable and combustible liquids*, and in consultation with the emergency services authority.

Transfer of hazardous chemicals

Transferring hazardous chemicals generally presents a far greater risk than static storage. Unconfined transfer of hazardous chemicals should be eliminated where possible, or, if that is not possible, steps should be taken to manage the risks of an unconfined transfer. Common methods for eliminating or reducing risks during transfer operations include:

- avoiding spillage or overflow, including overflow protection on equipment and receiving vessels
- providing emergency shut-offs to limit the amount of hazardous chemical released during a loss of containment
- providing a spill containment system
- reducing static electricity and vapour generation. This is particularly important for fire risk hazardous chemicals such as flammable liquids
- ensuring transfer fittings are compatible
- avoiding sources of ignition
- installing flow and pressure regulators on pipe work or pumps
- installing interlocking of valves and switches, and
- implementing systems for detecting losses from pipe work and fittings, such as static pressure loss detectors, measurement to determine losses in transfer, or external sensors.

Plumbed eye wash stations and safety showers should be installed in areas where workers may be exposed in the event of a spill during transfer operations.

Controlling risks from compressed gases

Key considerations for safe storage and handling of gas cylinders include:

- maintaining and regularly checking cylinders, regulators, hoses and pipes to cylinders to ensure that there are no leaks or dents
- storing cylinders in an upright position to ensure the safety device functions correctly
- securing cylinders to prevent dislodgement
- transport cylinders with appropriate equipment such as trolleys or gas cages
- keep the cylinder valve closed when the cylinder is not being used
- keep all sources of heat and ignition away from gas cylinders, even if the cylinders do not contain flammable material, and
- store cylinders outdoors or in very well ventilated areas.

Gas cylinders should be fitted with a bursting disc safety device and liquid petroleum gas (LPG) cylinders should have an operational spring-loaded pressure relief valve.

If a small leak occurs, the cylinder valve should be closed, if it is safe to do so. Appropriate PPE should be put on before attempting to locate the leak point. For toxic gases, self-contained breathing apparatus may be required for emergency use. The area should be well ventilated and air-conditioning systems should be turned off to avoid spreading gas. However, if a large amount of gas escapes, the area should be evacuated. If it is safe to do so, before evacuating, ventilate the area and remove or isolate ignition sources. Contact the gas supplier for advice, or in an emergency, contact the emergency services authority.

Potential risks associated with the transport and storage of small gas cylinders (for example, acetylene and LPG) in vehicles must also be managed appropriately.

A range of Australian Standards provide further information relating to controlling risks from compressed and liquefied gases, such as AS/NZS 1596: *The storage and handling of LP gas,* and AS 4332: *The storage and handling of gases in cylinders*.

Asphyxiation hazards

Key considerations in minimising the risk of asphyxiation include:

- avoiding working in oxygen-depleted (under 19%) atmospheres—air monitoring may need to be undertaken to determine if the atmosphere is safe
- keeping the work area well-ventilated, particularly in low-lying areas and roof spaces where gases can accumulate—this could be done by ensuring windows are open where necessary and ventilation and extraction systems are on and are fully functional
- purging contaminants from the atmosphere or the space where work is being carried out
- using an air-supplied respirator, particularly in confined spaces (see the *Code of Practice: Confined spaces* for further information), and
- checking cylinders, cylinder fittings, hoses and connections to ensure that they are not damaged or in poor condition—this might include checking fittings and hoses for signs of corrosion or degradation or spraying them with a small amount of detergent solution or leak-detection spray and looking for bubble formations which may indicate the presence of a gas leak.

4.3 Maintaining control measures

WHS Regulation 37

Maintenance of control measures

As a PCBU, you must ensure that the implemented control measures remain effective. This includes checking that the control measures are fit for purpose; suitable for the nature and duration of the work and are installed and used correctly.

Maintenance of control measures may involve the following:

- regular inspections of control measures
- supervision to ensure workers are using the control measures properly
- preventative maintenance and testing programs for chemical storage and handling systems, and
- periodic air monitoring to ensure that engineering and administrative controls remain effective.

Maintenance procedures should include mechanisms for workers to report defective control measures as soon as they are identified so that prompt remedial action can be taken.

Preventative maintenance and integrity testing

WHS Regulation 363

Control of risks from storage or handling systems

You must ensure, so far as is reasonably practicable, that a system used at the workplace for the use, handling or storage of hazardous chemicals is used only for the purpose for which it was designed, manufactured, modified, supplied or installed and is operated, tested, maintained, installed, repaired and decommissioned having regard to the safety of workers and other persons at the workplace.

Systems for the storage and handling of hazardous chemicals generally require ongoing maintenance and testing to ensure that they continue to be safe for the intended use and that they maintain their operational integrity. Such systems include, but are not limited to, reaction vessels, chemical transfer lines, pumps, spill bunding, storage tanks and filters.

To ensure that the integrity of chemical handling systems are preserved, planned maintenance programs should be designed and carried out at regular intervals, consistent with the manufacturer's instructions or advice provided by other competent persons. If this is not reasonably practicable, inspections and maintenance should be carried out annually.

Examples of preventative maintenance and integrity testing might include:

- Inspection of glass linings on steel or metal alloy reaction vessels to ensure there are no cracks or holes which might allow contact of incompatible materials with the metal vessel.
- Regular checking of bursting (rupture) discs and pressure-relief systems on pressure vessels to ensure they have not 'blown' and are of the correct pressure rating for the work being performed. Bursting or rupture discs are safety features of cylinders that prevent damage or injury from over-pressurisation.
- Checking spill bunding walls for cracks or other signs of wear to ensure that, in the event of a spill, the bunding will not leak or fail.
- Checking for signs of corrosion or degradation on tanks, pipe work and compressed gas fittings.

If preventative maintenance checks show that the integrity of any chemical handling system is in doubt or not performing as it is intended, repair or replacement of the faulty system should be carried out as soon as practicable and before its next use.

4.4 Providing information, training, instruction and supervision

WHS Act section 19

Primary duty of care

WHS Regulation 39

Provision of information, training and instruction

The WHS Act requires that a PCBU ensure, so far as reasonably practicable, the provision of any information, training, instruction or supervision that is necessary to protect all persons from risks to their health and safety arising from work carried out as part of the conduct of the business or undertaking.

As a PCBU you must ensure that information, training or instruction provided to a worker is suitable and adequate having regard to:

- the nature of the work carried out by the worker
- the nature of the risks associated with the work at the time the information, training or instruction is provided, and
- the control measures implemented.

You must also ensure, so far as is reasonably practicable, that the information, training and instruction are provided in a way that is readily understandable for the worker to whom it is provided.

Workers must be trained and have the appropriate skills to carry out a particular task safely. Training should be provided to workers by a competent person.

WHS Regulation 379

Duty to provide supervision

In addition to your general duty to provide any supervision necessary to protect all persons from work health and safety risks, the WHS Regulations also impose specific duties to provide supervision necessary to protect a worker from risks to health and safety where the worker:

- uses, handles, generates or stores a hazardous chemical
- operates, tests, maintains, repairs or decommissions a storage or handling system for a hazardous chemical, or
- is likely to be exposed to a hazardous chemical.

Information, training, instruction and supervision must be provided not only to workers but to other persons at the workplace such as visitors.

Information, training and instruction should include the following:

- the nature of the hazardous chemicals involved and the risks to the worker
- the control measures implemented, how to use and maintain them correctly, for example how and when to clean or replace filters on a spray-painting booth
- the arrangements in place to deal with emergencies, including evacuation procedures, containing and cleaning up spills and first aid instructions
- the selection, use, maintenance and storage of any PPE required to control risks and the limitations of the PPE
- any health monitoring which may be required and the worker's rights and obligations
- the labelling of containers of hazardous chemicals, the information that each part of the label provides and why the information is being provided
- the availability of SDS for all hazardous chemicals, how to access the SDS, and the information that each part of the SDS provides, and
- the work practices and procedures to be followed in the use, handling, processing, storage, transportation, cleaning up and disposal of hazardous chemicals.

The WHS Regulations also include specific requirements to provide information, training and instruction regarding:

- the proper use, wearing, storage and maintenance of PPE
- undertaking work in confined spaces
- emergency procedures, and
- storage and handling systems for hazardous chemicals.

Information, training and instruction must be provided in such a way that it is easily understood. The amount of detail and extent of training will depend on the nature of the hazards and the complexity of the work procedures and control measures required to minimise the risks.

Records of training provided to workers should be kept, documenting who was trained, when and on what.

5. Monitoring and review

5.1 Health monitoring

WHS Regulation 368

Duty to provide health monitoring

As a person conducting a business or undertaking (PCBU), you must ensure health monitoring is provided to a worker carrying out work for the business or undertaking if:

- the worker is carrying out ongoing work using, handling, generating or storing hazardous chemicals and there is a significant risk to the worker's health because of exposure to a hazardous chemical referred to in Schedule 14, table 14.1 of the WHS Regulations, and
- the person identifies that because of ongoing work carried out by a worker using, handling, generating or storing hazardous chemicals there is a significant risk that the worker will be exposed to a hazardous chemical (other than a hazardous chemical referred to in Schedule 14, table 14.1 of the WHS Regulations) and either:
- valid techniques are available to detect the effect on the worker's health, or
- a valid way of determining biological exposure to the hazardous chemical is available and it is uncertain, on reasonable grounds, whether the exposure to the hazardous chemical has resulted in the biological exposure standard being exceeded.

Health monitoring of a worker means monitoring the worker to identify changes in their health status because of exposure to certain substances. It involves the collection of data to measure exposure or evaluate the effects of exposure and to determine whether or not the absorbed dose is within safe levels.

Health monitoring allows decisions to be made about implementing ways to eliminate or minimise the worker's risk of exposure, for example reassigning a worker to other duties that involve less exposure, or improving control measures.

Schedule 14, table 14.1 includes the type of health monitoring that must be carried out for each hazardous chemical listed, unless:

- an equal or better type of health monitoring is available, and
- the use of that other type of monitoring is recommended by a registered medical practitioner with experience in health monitoring.

Health monitoring is not an alternative to implementing control measures. Health monitoring is a way of identifying if control measures are effective. If the results of health monitoring indicate that a worker is experiencing adverse health effects or signs of exposure to a hazardous chemical, the control measures must be reviewed and if necessary revised.

You must:

- inform workers and prospective workers about health monitoring requirements
- ensure health monitoring is carried out by or under the supervision of a registered medical practitioner with experience in health monitoring
- consult workers in relation to the selection of the registered medical practitioner
- pay all expenses relating to health monitoring
- provide certain information about a worker to the registered medical practitioner
- take all reasonable steps to obtain a report from the registered medical practitioner as soon as practicable after the monitoring has been carried out
- provide a copy of the report to the worker as soon as practicable after obtaining the report
- provide a copy of the report to the regulator if the report contains test result that indicate the worker may have contracted a disease, injury or illness or recommends remedial measures should be taken as a result of the work that triggered the requirement for health monitoring
- provide the report to all other persons conducting a business or undertaking who have a duty to provide health monitoring for the worker as soon as reasonably practicable after obtaining the report
- keep reports as confidential records for at least 30 years after the record is made (40 years for reports relating to asbestos exposure), and
- not disclose the report to anyone without the worker's written consent unless required under the WHS Regulations.

The WHS Regulations also contain specific requirements relating to health monitoring for lead and asbestos. Further information on health monitoring can be found in SWA's Health monitoring for persons conducting a business or undertaking guide.

5.2 Reviewing control measures

WHS Regulation 38

Review of control measures

You must review and, as necessary, revise control measures so as to maintain, so far as is reasonably practicable, a work environment that is without risks to health or safety.

WHS Regulation 352

Review of control measures

You must also ensure that any measures implemented to control risks in relation to a hazardous chemical at the workplace are reviewed and as necessary revised.

Control measures must be reviewed (and revised if necessary) in the following circumstances:

- when the control measure does not control the risk it was implemented to control so far as is reasonably practicable
- before a change at the workplace that is likely to give rise to a new or different risk to health and safety that the measure may not effectively control
- a new relevant hazard or risk is identified
- the results of consultation indicate that a review is necessary
- a health and safety representative requests a review if that person reasonably believes that:
    - a circumstance in any of the above points affects or may affect the health and safety of a member of the work group represented by the health and safety representative
    - the control measure has not been adequately reviewed in response to the circumstance.
- if an SDS or register of hazardous chemicals is changed
- if a health monitoring report for a worker contains:
- test results that the worker has been exposed to a hazardous chemical and has an elevated level of the chemical or metabolites for that hazardous chemical in their body
- any advice that test results indicate the worker may have contracted a disease, injury or illness as a result of carrying out the work that triggered the need for health monitoring
- any recommendation that the PCBU take remedial measures, including whether the worker can continue to carry out the type of work that triggered the requirement for health monitoring.
- if air monitoring indicates that the airborne concentration of a hazardous chemical at the workplace exceeds the relevant exposure limit, and
- at least once every five years.

A change at the workplace includes:

- a change to the workplace itself or any aspect of the work environment, and
- a change to a system of work, a process or a procedure.

Common review methods include workplace inspection, consultation, testing and analysing records and data.

You can use the same methods as in the initial hazard identification step to check control measures. When reviewing the control measures, consultation must occur with workers and their health and safety representatives. The following questions should be considered when undertaking the review:

- Are the control measures working effectively in both their design and operation?
- Have the control measures introduced new problems?
- Have all hazards been identified?
- Have new work methods, new equipment or chemicals made the job safer?
- Are safety procedures being followed?
- Has the instruction and training provided to workers on how to work safely been successful?
- Are workers actively involved in identifying hazards and possible control measures? Are they openly raising health and safety concerns and reporting problems promptly?
- Are the frequency and severity of health and safety incidents reducing over time?
- If new legislation or new information becomes available, does it indicate current controls may no longer be the most effective?

If problems are found, go back through the risk management steps, review your information and make further decisions about risk control.

6. Emergency preparedness

Regardless of controls put in place to prevent incidents occurring in your workplace, they can still occur. For example, people can be exposed to chemicals and require immediate medical treatment, a fire can start, or a loss of containment can occur. It is therefore necessary to be prepared for any foreseeable incident.

6.1 Emergency plan

WHS Regulation 43

Duty to prepare, maintain and implement emergency plan

As a person conducting a business or undertaking (PCBU), you must prepare an effective emergency plan for the workplace.

WHS Regulation 361

Emergency plans

An emergency plan must be prepared and provided to the emergency services organisation if the quantity of Schedule 11 hazardous chemicals used, handled or stored at a workplace exceeds the manifest quantity for that hazardous chemical. You must revise the plan in accordance with any recommendations the primary emergency services organisation provides about its effectiveness.

The purpose of the emergency plan is to plan for, and thus minimise the effects of, any dangerous occurrence or near miss at a workplace resulting from handling of hazardous chemicals.

When developing an emergency plan, consideration must be given to the following factors:

- the nature of the work being carried out at the workplace
- the nature of the hazards at the workplace
- the size and location of the workplace, and
- the number of workers and other persons at the workplace.

For workplaces that use, store or handle large quantities of hazardous chemicals, providing a copy of emergency plans and details of actions to be taken in the event of an alarm or emergency situation to neighbouring sites may assist in coordinating responses in the event of an emergency.

Additional information regarding emergency management associated with the storage and handling of flammable hazardous chemicals is available in AS 1940: *The storage and handling of flammable and combustible liquids*.

More information about emergency plans can be found in SWA's *Emergency Plans Fact Sheet*, and information about emergency plans for major hazard facilities can be found in SWA's *Guide for Major Hazard Facilities—Emergency plans*.

Content of emergency plan

The emergency plan must provide for:

- emergency procedures that include:
  - an effective response to an emergency
  - evacuation procedures
  - notification procedures to advise emergency services organisations at the earliest opportunity
  - medical treatment and assistance
  - communication procedures between the person coordinating the emergency response and all persons at the workplace.
- the testing procedures and how often they will be done
- how relevant workers will be provided with information, training and instruction about implementing the emergency procedures.

A comprehensive emergency plan should also include:

- a site map that indicates where hazardous chemicals are stored
- responsibilities of key persons in managing emergencies
- circumstances to activate the plan
- systems for raising the alarm
- estimating the extent of the emergency
- alerting emergency services organisations to the emergency or if it has the potential to become a dangerous occurrence
- procedures that account for all people at the workplace
- isolation of the emergency area to prevent entry by non-essential personnel
- roles of on-site emergency response teams (including First Aid Officers, Emergency Wardens)
- containment of any spillage
- the requirement for firefighting water retention to ensure that contaminated firefighting water cannot enter waterways, drains or groundwater
- disconnection of power supplies and other energy sources except when required to maintain safety of a critical operation or to run emergency equipment such as fire booster pumps
- prevention of hazardous chemicals or contaminated material of any kind from entering drains or waterways
- provision of relevant information and assistance to the emergency services authority, both in anticipation of emergencies and when they occur
- maintenance of site security throughout the emergency
- provision for dealing with the public and the press, and
- site rehabilitation requirements.

Emergency procedures

The extent of emergency procedures required will depend on the size and complexity of the workplace, types and quantities of hazardous chemicals and the processes involved when the goods are in use. As a minimum, emergency procedures should include instructions on:

- how to raise the alarm, including how to contact the appropriate emergency services organisation
- any actions to be taken by workers in an emergency to ensure the safety and health of all persons at the workplace to minimise risks, damage to property as well as the environment, and
- any actions to be taken by prescribed persons such as fire wardens, for example how to evacuate the workplace or use fire extinguishers.

To be effective, workers need to be appropriately trained, and any procedures tested. Workers should be consulted and ideally directly involved in the development of emergency procedures.

An example of an effective emergency procedure is a simple one-page document in point form, suitable for display on signs or to be carried by workers or visitors as a pocket card, detailing evacuation procedures, assembly areas, identifying first aid officers and emergency wardens at the workplace, contact numbers of emergency services organisations (such as fire brigade, police, ambulance, local hospital and regulatory authorities).

Consultation and communication

The emergency plan must be developed in consultation with your workers, the primary emergency services organisation and neighbouring premises. The emergency services organisation should also be consulted when developing and designing fire protection systems used in the workplace.

Off-site considerations

Where any foreseeable incident may have effects beyond the boundary of the workplace, the emergency plan should also address managing the off-site effects. Where off-site effects are possible, the plan should contain information on necessary warnings or communications with neighbouring premises.

Where the emergency plan includes activities that involve persons who reside or work adjacent to the workplace, the relevant parts of the plan should be communicated to those persons.

Implementation and testing

The emergency plan should be tested when first devised and after each modification.

Throughout the year, at suitable intervals, practice drills and simulated emergencies should be undertaken and involve all workers and the emergency services authority. These drills should be focused on familiarising anyone who would be involved in an incident related to the storage and handling of hazardous chemicals with the workplace procedures.

Reviewing the emergency plan

The emergency plan should be reviewed:

- within five years of its development
- in intervals of no more than five years
- if there is a change of risk at or in the proximity of the workplace
- when updated information becomes available, or
- if a possible deficiency is identified, for example through regular testing.

Emergency plans should be readily available in hard copy form at all times. The location of the emergency plan should be easily located by all workers and should be discussed with the emergency services organisation when it is updated or reviewed.

6.2 Emergency equipment and safety equipment

WHS Regulations Part 7.1 Division 5: Subdivision 3

Emergency plans and safety equipment

As a PCBU that uses, handles, generates or stores hazardous chemicals you must ensure that equipment is always available at the workplace for use in an emergency.

The type of emergency equipment required to respond to an emergency, contain and clean up spills and assist workers in conducting emergency procedures safely will vary depending on the type and quantities of hazardous chemicals at the workplace.

Equipment must be located so it is readily accessible for all workers if an emergency arises. If safety equipment is needed to respond to an emergency, you must ensure that it is provided, maintained and readily accessible at the workplace. Safety equipment for use with hazardous chemicals should be compatible with the hazardous chemicals they may come in contact with. For example, water fire extinguishers must not be used on oil fires.

Examples of emergency equipment that may be required in your workplace include:

- over packs such as oversized drums for containing leaking containers
- absorbent material suitable for the chemical likely to be spilled
- booms, plates and/or flexible sheeting for preventing spillage from entering drains and waterways
- fire extinguishers
- neutralising agents such as lime and soda ash
- suitable pumps and hoses for removing spilled material
- first aid kits (including antidotes for specific chemical exposures such as cyanide)
- emergency showers and eye wash stations
- hand tools such as mops, buckets, squeegees and bins, and
- suitable protective clothing and equipment to protect the safety and health of personnel involved in the clean-up.

6.3 Fire protection systems

WHS Regulation 359

Fire protection and firefighting equipment

As a PCBU, you must ensure that fire protection and firefighting equipment:

- is designed and built for the types of hazardous chemicals at the workplace in the quantities in which they are used, handled, generated or stored at the workplace and the conditions under which they are used, handled, generated or stored
- is compatible with firefighting equipment used by the primary emergency service organisation
- is properly installed, tested and maintained, and
- has its latest testing date recorded and test results are kept until the next test is conducted.

Where large quantities of hazardous chemicals are used, handled, generated or stored in your workplace simple fire extinguishers may not be sufficient to deal with a fire. In these cases you need to consider installing a fire protection system that is designed for the types and quantities of hazardous chemicals used, handled, generated or stored in your workplace.

When installing a fire protection system you must have regard to:

- the fire load of the hazardous chemicals and from other sources
- the compatibility of the hazardous chemicals with other substances or mixtures at the workplace, and
- the compatibility of the equipment with equipment used by the primary emergency service organisation.

You should also consider the proximity of the workplace to other workplaces or premises and any requirements under the Building Code of Australia.

The fire protection system should have the capacity to quickly control and extinguish any fire that occurs involving the hazardous chemicals. It should also effectively protect the hazardous chemicals stored within the workplace from any fire in adjacent properties.

If at any stage the fire protection or firefighting equipment becomes ineffective or inoperable, you must assess the implications of having an unserviceable or inoperative system and must control the risk with alternative measures. In these circumstances you should make sure that alternative arrangements are made immediately. If alternative resources cannot be obtained to provide the required level of protection, it may be necessary to cease operating until effective fire protection can be restored. You must ensure that the fire protection and firefighting equipment are returned to full operation as soon as possible.

6.4 Monitors and alarms

Monitors and alarms can be critical to controlling an emergency situation as they allow the emergency or dangerous situation to be identified early and response actions initiated quickly. Effective alarm systems should:

- activate automatically and be capable of being operated manually through the use of clearly identified alarm activators at convenient and safe locations, that are easily accessible to work areas
- utilise alarm signals that are distinguishable from any other signal and are clearly audible throughout the premises
- contain a visual component (for example, flashing lights) in situations where there are high noise levels or the use of protective clothing may prevent the recognition of an alarm signal, and
- remain operable if the main power supply fails.

Monitors and alarms should be installed in accordance with manufacturers' specifications. Fire alarms should be installed where fire control may require the direction of large quantities of firefighting water (or equivalent) at a fixed installation, with minimum exposure to risks for fire fighters. Where large quantities of hazardous chemicals are involved, it is recommended that this be done in consultation with the relevant emergency services authority.

To ensure that monitors and alarms remain effective, they should be tested regularly.

6.5 Automatic sprinkler systems

Depending on the level of risk, you may choose to install an automatic sprinkler system. Automatic sprinkler systems may allow the fire to be controlled almost immediately after it starts. However, they may not be suitable in all workplaces, for example where use of water as the extinguishing agent is not appropriate because of the presence of chemicals that react with water. Automatic sprinkler systems may comprise:

- individual-actuation sprinklers
- deluge sprinklers
- foam sprinklers, or
- a combination of any of the above.

6.6 Water supply

A reliable water supply is required to ensure that the protection system remains operable in case of an emergency. The supply should be sufficient to supply both the internal fire protection equipment and additional equipment used by the emergency services organisation controlling a fire at the premises.

Where sufficient supply is not available from the main water supply, it may be necessary to supplement this with additional water storage and/or pumps. If the local authorities permit it, water may be obtained from reliable alternative sources such as close-by rivers and dams, using whatever resources are suitable.

The emergency services organisation that is attending a fire at the workplace should be requested to conduct regular checks on the adequacy of the local water supply and water pressure within the workplace.

Appendix A—Glossary

Table 5 The meaning of key terms

Key terms	Meaning
ADG Code	The Australian Code for the Transport of Dangerous Goods by Road and Rail, as in force or remade from time to time, approved by the Transport and Infrastructure Council. The ADG Code is accessible at the National Transport Commission website www.ntc.gov.au.
Acute toxicity	Serious adverse health effects (i.e., lethality) occurring after a single or short-term oral, dermal or inhalation exposure to a substance or mixture.
Article	A manufactured item, other than a fluid or particle, that is formed into a particular shape or design during manufacture and has hazard properties and a function that are wholly or partly dependent on the shape or design.
Biological monitoring	The measurement and evaluation of a substance, or its metabolites, in the body tissue, fluids or exhaled air of a person exposed to that substance, such as blood lead level monitoring.
Carcinogen	A substance or a mixture which causes cancer.
Combustible substance	A substance that is combustible and includes dust, fibres, fumes, mists or vapours produced by the substance.
Container	Anything in or by which a hazardous chemical is, or has been, wholly or partly covered, enclosed or packed, including anything necessary for the container to perform its function as a container.
Correct classification	The set of hazard classes and hazard categories assigned to a hazardous chemical when it is correctly classified. *Note: Part 1 of Schedule 9 of the WHS Regulations sets out when a hazardous chemical is correctly classified.*
Duty holder	Any person who owes a work health and safety duty under the WHS Act including a person conducting a business or undertaking, a designer, manufacturer, importer, supplier, installer of products or plant used at work (upstream duty holder), officer or a worker.
Exposure limit	An exposure limit published by Safe Work Australia in the *Workplace exposure limits for airborne contaminants* It represents the airborne concentration of a particular substance or mixture that must not be exceeded.
Flash point	The lowest temperature (corrected to a standard pressure of 101.3 kPa) at which the application of an ignition source causes the vapours of a liquid to ignite under specified test conditions.
GHS	The *Globally Harmonized System of Classification and Labelling of Chemicals, 7th Revised Edition*, published by the United Nations as modified by Schedule 6 to the WHS Regulations.
Hazard	A situation or thing that has the potential to harm a person. Hazards at work may include: noisy machinery, a moving forklift, chemicals,

	electricity, working at heights, a repetitive job, bullying and violence at the workplace.
Hazard category	A division of criteria within a hazard class in the GHS.
Hazard class	The nature of a physical, health or environmental hazard under the GHS. *Note: This includes dangerous goods.*
Hazardous area	An area in which: • an explosible gas is present in the atmosphere in a quantity that requires special precautions to be taken for the construction, installation and use of plant, or • a combustible dust is present or could reasonably be expected to be present in the atmosphere in a quantity that requires special precautions to be taken for the construction, installation and use of plant.
Hazardous chemical	Any substance, mixture or article that satisfies the criteria for any one or more hazard classes in the GHS (including a classification referred to in Schedule 6 of the WHS Regulations), unless the only hazard class or classes for which the substance, mixture or article satisfies the criteria are any one or more of the following: • acute toxicity—oral—category 5 • acute toxicity—dermal—category 5 • acute toxicity—inhalation—category 5 • skin corrosion/irritation—category 3 • aspiration hazard—category 2 • flammable gas—category 2 • acute hazard to the aquatic environment—category 1, 2 or 3 • chronic hazard to the aquatic environment—category 1, 2, 3 or 4 • hazardous to the ozone layer. Note: The Schedule 6 tables replace some tables in the GHS.
Hazard pictogram	A graphical composition, including a symbol plus other graphical elements, that is assigned in the GHS to a hazard class or hazard category.
Hazard statement	A statement assigned in the GHS to a hazard class or hazard category describing the nature of the hazards of a hazardous chemical including, if appropriate, the degree of hazard.
Health and safety committee	A consultative body established under the WHS Act. The committee's functions include facilitating cooperation between workers and the person conducting a business or undertaking to ensure workers' health and safety at work, and assisting to develop work health and safety standards, rules and procedures for the workplace.
Health and safety representative	A worker who has been elected by their work group under the WHS Act to represent them on health and safety matters.

Label	Written, printed or graphical information elements concerning a hazardous chemical that is affixed to, printed on, or attached to the container of a hazardous chemical.
Manufacture	The activities of packing, repacking, formulating, blending, mixing, making, remaking and synthesising of the chemical.
May	'May' indicates an optional course of action.
Mixture	A combination of, or a solution composed of, two or more substances that do not react with each other.
Must	'Must' indicates a legal requirement exists that must be complied with.

Officer	• An officer under the WHS Act includes:
	  ○ an officer within the meaning of section 9 of the Corporations Act 2001 (Commonwealth)
	  ○ an officer of the Crown within the meaning of section 247 of the WHS Act, and
	  ○ an officer of a public authority within the meaning of section 252 of the WHS Act.
	• A partner in a partnership or an elected member of a local authority is not an officer while acting in that capacity.

Person conducting a business or undertaking (PCBU)	A PCBU is an umbrella concept which intends to capture all types of working arrangements or relationships. A PCBU includes a: • company • unincorporated body or association • sole trader or self-employed person. • Individuals who are in a partnership that is conducting a business will individually and collectively be a PCBU. A volunteer association (defined under the WHS Act, see below) or elected members of a local authority will not be a PCBU.
Placard	A sign or notice displayed or intended for display in a prominent place, or next to a container or storage area for hazardous chemicals at a workplace, that contains information about the hazardous chemical stored in the container or storage area.
Placard quantity	The quantity referred to in Schedule 11 of the WHS Regulations, table 11.1, column 4 for that hazardous chemical.
Precautionary Statement	A phrase prescribed by the GHS that describes measures that are recommended to be taken to prevent or minimise the adverse effects of exposure to a hazardous chemical or the improper handling of a hazardous chemical.
Risk	The possibility harm (death, injury or illness) might occur when exposed to a hazard.
Sensitiser	A substance or mixture that causes an allergic response following skin contact or induces hypersensitivity of the airways following inhalation

Should	‘Should’ indicates a recommended course of action.
Substance	A chemical element or compound in its natural state or obtained or generated by a process: • including any additive necessary to preserve the stability of the element or compound and any impurities deriving from the process, but • excluding any solvent that may be separated without affecting the stability of the element or compound, or changing its composition.
Supply	Selling or transferring ownership or responsibility for a chemical.
Volunteer association	A group of volunteers working together for one or more community purposes where none of the volunteers, whether alone or jointly with any other volunteers, employs any person to carry out work for the volunteer association.
Work group	A group of workers established to facilitate the representation of workers by one or more health and safety representatives. A work group may be all workers at a workplace but it may also be appropriate to split a workplace into multiple work groups where workers share similar work conditions or are exposed to similar risks and hazards. For example all workers on night shift.
Worker	Any person who carries out work for a person conducting a business or undertaking, including work as an employee, contractor or subcontractor (or their employee), self-employed person, outworker, apprentice or trainee, work experience student, employee of a labour hire company placed with a 'host employer' or a volunteer.
Workplace	Any place where work is carried out for a business or undertaking and includes any place where a worker goes, or is likely to be, while at work. This may include offices, factories, shops, construction sites, vehicles, ships, aircraft or other mobile structures on land or water.

Appendix B—Overview of a risk assessment process

An overview of the process for the assessment of health risks arising from the use of hazardous chemicals in the workplace is provided below.

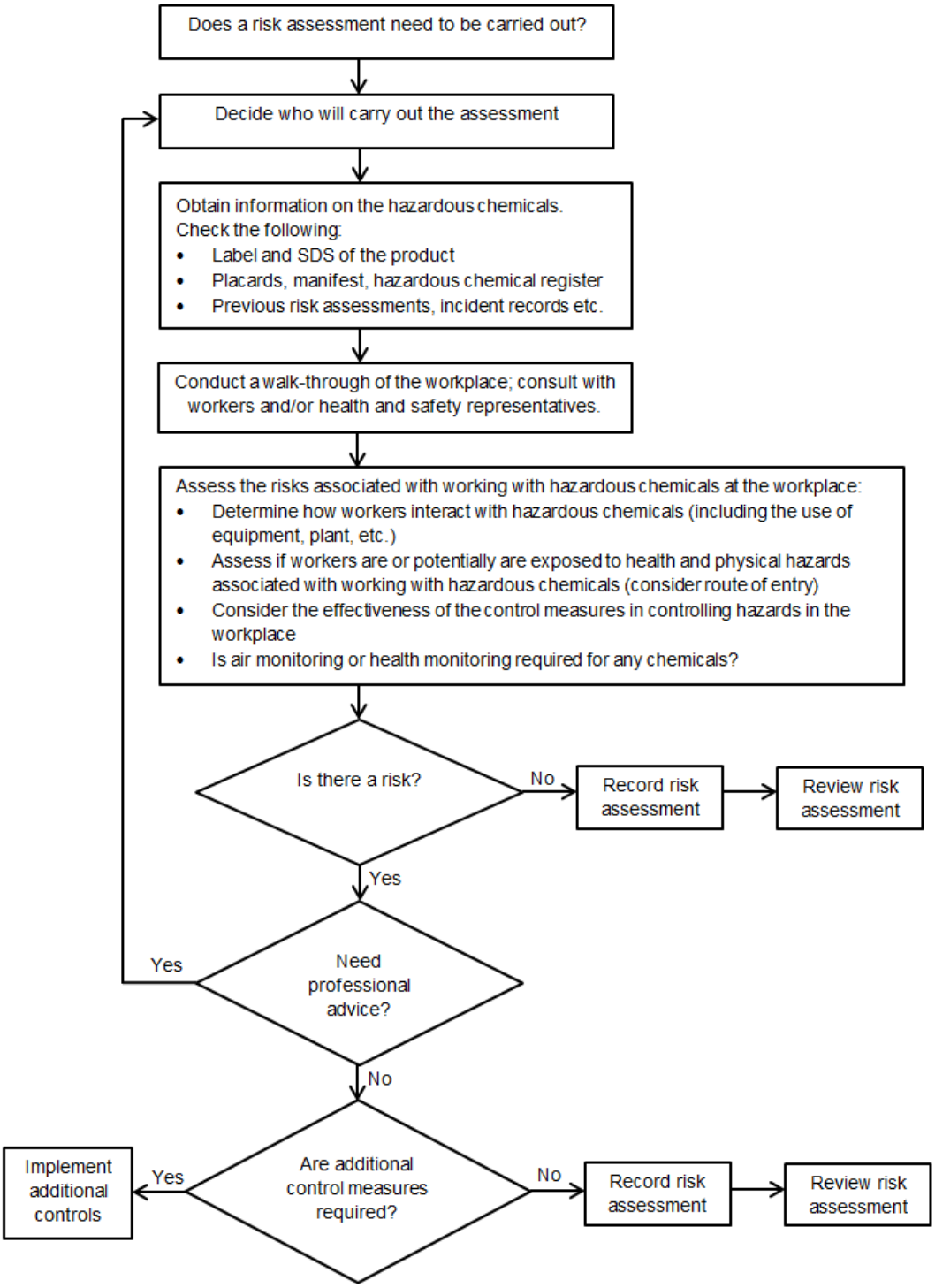


Figure 4: Overview of the process for the assessment of health risks arising from the use of hazardous chemicals in the workplace

Appendix C—Risk assessment checklist

Table 6 Risk assessment checklist

Questions	Yes	No
1. Does a risk assessment need to be carried out?	☐	☐
2. Has it been decided who should carry out the risk assessment?	☐	☐
3. Have all the hazardous chemicals in the workplace been identified? Has a hazardous chemical register been produced?	☐	☐
4. Has information about the hazardous chemicals been gathered? (refer to labels, SDS, placards and relevant Australian Standards for the type of hazardous chemical)	☐	☐
Q. 5–9 should be answered for each hazardous chemical or each process where hazardous chemicals are used in the workplace		
5. Have you checked other records associated with the hazardous chemical? (consider previous assessments, monitoring records, injury or incident records, induction training, task-specific training etc) If 'Yes', are there any hazardous chemical risks previously assessed as 'high' or as 'significant risk'? Specify the risk(s).	☐	☐
6. Does the chemical have health hazards? (consider potential acute/chronic health effects and likely route of entry)	☐	☐
7. Does the hazardous chemical have physical hazards?	☐	☐
8. Does the hazardous chemical have an exposure limit? (refer to the *Workplace exposure limits for airborne contaminants*)	☐	☐
9. Do workers using the hazardous chemical require health monitoring? (refer to Part 7.1, Division 6 and Schedule 14 of the WHS Regulations) If 'Yes', air monitoring may be required.	☐	☐
10. Are workers, or can workers be potentially, exposed to hazardous chemicals at the workplace, including by-products and waste? For each hazardous chemical or group of hazardous chemicals in the work unit, find out: • Is the substance released or emitted into the work area? • Are persons exposed to the chemical? • How much are the persons exposed to and for how long? Air monitoring may be required to determine exposure. • Are there any risks associated with the storage and transport of the chemical?	☐	☐

11. Are control measures currently in the workplace well maintained and effective in controlling the hazards? If 'No', take appropriate action.	☐	☐
12. What are the conclusions about risk? Only answer 'Yes' to one conclusion. • Conclusion 1: Risks are not significant • Conclusion 2: Risks are significant but effectively controlled If you answer Yes to conclusion 1 or 2, go to Q.14. • Conclusion 3: Risks are significant and not adequately controlled • Conclusion 4: Uncertain about risks If you answer 'Yes' to conclusion 3 or 4, go to Q.13.	☐	☐
13. Have actions resulting from conclusion about risks been identified? • Seek expert advice • Requires appropriate control measure • Requires induction training • Requires ongoing monitoring • Requires health monitoring • Requires emergency procedures and first aid	☐	☐
14. Has the assessment been recorded?	☐	☐

Appendix D—Practical examples of control measures

The following table illustrates some situations involving risks from hazardous chemicals that may be encountered in the workplace, and provides some examples of controls that may be considered to eliminate or minimise the risks. The conclusions you make in your assessment should be supported by clear and valid evidence.

Table 7 Examples of risks from hazardous chemicals in the workplace

Examples of risks	Examples of controls
Use of petrol or diesel powered vehicles in poorly ventilated work areas	Ensure adequate ventilation. Consider use of electric vehicles.
Activities which involve prolonged skin contact with hazardous chemicals that are either readily absorbed through the skin or that can directly affect the skin	Change work practices to avoid skin contact, or select and use appropriate PPE to control exposure.

Handling of caustic or acidic chemicals where there is a potential for splashes onto the skin or eyes	Consider installing automated systems to dispense or transfer chemicals between containers. Use eye protection. Provide an emergency eye wash facility.
Dry sweeping of fine particulates	Use vacuum cleaning as an alternative, or wet cleaning methods.
Manually cleaning printing screens or large printing rollers with large quantities of volatile solvents	Automate or enclose the process and ensure adequate ventilation. Use non-volatile solvents or detergent/water-based cleaning solutions.
Processes for which monitoring results approach or exceed exposure limits	Upgrade ventilation systems so that monitoring results are well below the exposure limit. More efficient ventilation systems may avoid the need for expensive air monitoring in some situations.
Evidence of significant quantities of fine deposits on workers and surfaces, or processes that generate fine mists or solid particulates (including fumes) within the breathing zones of workers	Review control measures of the process to minimise release of particles at the source. Examples may include enclosing the process or installing ventilation systems. Review and revise housekeeping procedures to remove dust build-up more frequently.
Application of volatile chemicals over large surface areas	Substitute less volatile and hazardous solvents.

Safe management of higher hazard chemicals

The following information provides more specific guidance and recommendations on managing the risks for particular types of hazardous chemicals, primarily those hazardous chemicals that have physical hazards. It gives in more detail some precautions that you should consider to assist in the safe management of higher hazard chemicals like gases under pressure, flammable liquids and solids, self-reactive and oxidising substances as well as advice on how to manage the risks during the abandonment or removal of underground storage tanks.

Gas cylinders (gases under pressure)

Used or empty cylinders should be treated with the same precautions as for full cylinders, since residual hazards remain.

Testing and maintenance of gas cylinders

Gas cylinders need to be tested periodically to ensure that they remain safe to use. A poorly maintained gas cylinder can leak, exposing workers to harmful or potentially explosive vapours, or fail catastrophically. In-built safety features may also become inoperable over time. Details of inspection and testing for gas cylinders are provided in AS 2030.1: *Gas cylinders—General requirements*.

As a guide, gas cylinders should be tested every 10 years for dry gases and more frequently for damp or corrosive gases—check with the gas supplier if you need advice. The last test date will be stamped on the cylinder near the valve or on the collar, or on the foot ring of some small cylinders. If the test period has expired, the cylinder may be unsafe to use and it

should not be refilled until it is re-tested (and receives a new date stamp). However, it is permissible to use up the cylinder's contents after its test date has expired, prior to testing. Alternatively it could be replaced with a new cylinder. Testing stations can give advice on disposal of a used cylinder if you wish to replace it. Owners of cylinders should keep records of testing and test dates.

Storage and handling of gas cylinders

Cylinders may be stored safely by following these steps:

- any cap provided for use with a cylinder is kept in place on the cylinder at all times when the cylinder is not being filled and not connected for use
- the cylinder valve is kept securely closed when not in use, including when empty (unless the cylinder is connected by permanent piping to a consuming device)
- any removable valve protection cap or valve outlet gas tight cap or plug is kept in place on the cylinder at all times (unless the cylinder is being filled or connected for use)
- keep the cylinder secured against unintended movement by installing chains preventing the cylinder from falling
- do not lubricate valves or attempt repair of leaks—if the valve is not closing properly, immediately remove the cylinder to a safe area outdoors and seek expert assistance
- have a water hose or fire extinguisher handy to put out any small fire close to the cylinder—a water spray can also be used to keep the cylinder cool in the event of a fire.

To ensure the in-built safety features of a cylinder function correctly, cylinders of liquefied flammable gas need to be positioned so that the safety relief device is in direct contact with the vapour space within the cylinder. Keep the cylinder upright, unless the design permits other positions—this depends on the position and operation of the relief device. If in doubt check the manufacturer's or supplier's instructions.

For further guidance on safe storage and handling of gas cylinders, refer to AS 4332: *The storage and handling of gases in cylinders.*

Further advice on storage and handling of specific gases is available from the following Australian Standards:

- AS/NZS 2022: Anhydrous ammonia—Storage and handling
- AS 1894: The storage and handling of non-flammable cryogenic and refrigerated liquids
- AS/NZS 2927: The storage and handling of liquefied chlorine gas
- AS 3961: The storage and handling of liquefied natural gas
- AS/NZS 1596: The storage and handling of LP gas
- AS 4839: The safe use of portable and mobile oxy-fuel gas systems for welding, cutting, heating and allied processes
- AS 4289: Oxygen and acetylene gas reticulation systems.

Unodourised liquefied petroleum gas (LP gas) or dimethyl ether

Although the sense of smell should not be relied upon to detect gas leaks and hazardous chemicals, it can often provide some level of warning to nearby workers in some instances. Unodourised LP gas can be particularly hazardous and, due to the absence of any discernible odour, it cannot be detected by the sense of smell. Dimethyl ether (DME), a highly flammable gas, is often used as a propellant for LP gas.

The risks from storing and using unodourised LP gas can be reduced by using the following control measures:

- Keep the storage and handling of unodourised LP gas or DME to a minimum, and restrict uses to those for which no less hazardous alternative is available (for example, aerosol propellant).
- The area where it is stored and handled should be well ventilated, or in a room designed for that purpose fitted with explosion ventilation, or in the open. Access to these areas should be restricted to essential personnel.
- Gas detection equipment should be installed to detect gas where an explosive atmosphere could develop. The gas detector should provide an automatic alarm before dangerous levels of gas are reached so that immediate action may be taken. The gas detector should emit an audible sound and have a visual display.

Flammable liquids in packages and in bulk

Australian Standard AS 1940: *The storage and handling of flammable and combustible liquids* provides guidance on the safe storage and handling of flammable and combustible liquids, including aspects such as package stores, bulk storage, tank design, pipe work and valves.

Abandoning or removing underground tanks of flammable liquids

The WHS Regulations require notification to the regulator when an underground, partially underground or fully mounded tank containing flammable liquids or flammable gases is to be abandoned. When the container no longer contains hazardous chemicals, placards and signs should be removed.

Any work on existing or abandoned underground tanks or associated pipe work is potentially dangerous where residual levels of the flammable gases, liquids and vapours are present. Introducing an ignition source may cause an explosion or other dangerous occurrence unless suitable procedures are adopted.

Tar-like deposits and sludge may have accumulated in the tank and pipe work. Flushing with water may not remove them and vapour testing may not detect this. Exposure of these deposits to air and sunlight under normal temperatures, or work involving heat (for example, use of grinders or oxy-acetylene cutting), may release vapours creating a potential explosion hazard.

By following the steps listed below, the likelihood of dangerous occurrences can be minimised or even eliminated:

- Remove the tank from the ground and transport to a disposal area and arrange for the tank to be decommissioned.
- Fill the tank with an inert solid material like concrete or sand.

- If it is intended that the tank be used again (within two years), you can fill the tank with water and a corrosion inhibitor.

Further information on removal and disposal of underground tanks is available in Australian Standards, for example AS 4976: *The removal and disposal of underground petroleum storage tanks*.

Self-reactive substances and mixtures, flammable solids, pyrophoric liquids and solids, self-heating substances and mixtures and substances which in contact with water emit flammable gas

There are a number of key considerations for controlling the fire risks from storing and handling the above types of hazardous chemicals. These include:

- ensuring non-combustible materials are used in the construction of buildings and storage areas
- installing and maintaining appropriate fire protection systems
- utilising separation distances (or barriers such as fire resistant screen walls)
- ensuring ignition and heating sources are controlled within the storage and handling areas, for example, electrical equipment used in these areas is intrinsically safe
- ensuring adequate ventilation and/or extraction is provided to avoid creation of a hazardous atmosphere or hazardous area
- installation of explosion doors or vents if there is the potential that flammable gases or vapour could be formed or there is the potential to form combustible dusts
- ensuring that the storage area is moisture free and protected from the elements
- ensuring that measures are taken to protect light or temperature sensitive materials, for example, by installing temperature controls or protecting from direct sunlight.

Tanks to be used for storing or handling these hazardous chemicals should be designed and operated to ensure that:

- moisture cannot enter the tanks
- valves and fittings are readily accessible, easily operated and operate as designed
- if practicable, remote operation for primary shut off valves at the tank is provided.

Flammable solids

Nitrocellulose film and other nitrocellulose products—handling and storage

Nitrocellulose film and products containing nitrocellulose can represent a significant explosion hazard if the risks are not properly controlled. Risks can be minimised by:

- reducing the amount of material stored or handled in the work area at any one time
- ensuring the storage and handling area is constructed from non-combustible materials
- ensuring there is sufficient means of escape in the event of an emergency. For example, use of outward opening doors, and removing all non-essential furniture and equipment from the work area to allow unimpeded access to the emergency exit
- eliminating all ignition sources, including

    - using intrinsically safe electrical wiring and equipment suitable for use in hazardous areas
    - guard or enclose heating elements and other electrical equipment to prevent ignition or decomposition of any nitrocellulose products
    - keeping the temperature of any surfaces and equipment (including enclosures) to a suitably safe temperature for the material being used.
- installation of an automatic sprinkler system
- preventing accumulations of excessive amounts of waste materials
- displaying suitable signs warning of hazards and precautions (for example, ‘No smoking’).

Oxidising agents

Oxidising substances are hazardous chemicals that are reactive and can support combustion. They can react and are incompatible with a range of other substances including organic materials (wood, paper) and hydrocarbon solvents. You should always refer to the SDS to check for any incompatibilities with the materials you are using, storing or handling.

Unintended dangerous reactions of oxidising agents can be avoided by observing the following precautions:

- keep away from combustible or readily oxidisable materials, including fuel containers, sulphur and powdered metal and any other incompatible materials. Stores of oxidisers should be a reasonable distance away (for example, at least 5 m)
- place packages and containers on clean pallets, racks or shelving to allow easier detection of leaks and to prevent contact with other substances. Some oxidising chemicals can ignite on contact with timber, therefore old and weathered pallets should not be used

- eliminate sources of heat if practicable. If this is not practicable, ensure that heat sources do not allow the oxidising agents to be heated to within about 15°C of their decomposition temperature
- keep packages closed when not in use to avoid spillage
- do not park or drive any vehicles (for example, forklifts) nearby because heat from the engine or fuel or oil leaks may cause a dangerous occurrence
- do not store any liquids above oxidising agents in case leaks cause incompatible materials to spill onto the oxidising substance
- do not allow accumulation of dust and keep surfaces clean in areas where oxidising substances are handled in the workplace
- clean up spillages immediately and dispose of waste in accordance with your local regulations. Do not mix substances in the waste bin because they might react or cause a fire.

Solid (dry) pool chlorine

If your workplace keeps large quantities of solid (dry) pool chlorine on the premises, avoid dangerous reactions by observing the precautions listed above for Oxidising agents. You should also ensure that the pool chlorine is kept a safe distance away (for example, at least 10 m) from any ammonium salt like ammonium sulfate, or be separated from it by suitable bunding.

Organic peroxides

Organic peroxides are capable of self-reaction and stabilisers are usually necessary. Some are classified as ‘Goods too dangerous to be transported’ and extreme caution is needed when storing or handling these materials.

Like oxidising agents, organic peroxides can be highly reactive with incompatible materials and precautions are necessary to avoid unintended reactions occurring. Risks can be eliminated or minimised by observing the following precautions:

- keep packages in a specifically designated and designed cabinet, room or external storage building containing explosion vents and/or doors to limit the effects in the event of an explosion
- keep a suitable safety zone (for example, 5 m) opposite the cabinet or storeroom doors and blow out panels
- use cabinet doors with friction or magnetic catches to allow any pressure build-up to escape more easily
- keep nothing else in the organic peroxides store. If this is not practicable, then measures should be taken to ensure that incompatible materials cannot come into contact with the organic peroxides
- keep the storage area free of waste, dirt, dust or metal filings (these could react with spillages) or any combustible materials
- eliminate ignition sources inside, or outside within a suitable exclusion zone (for example, 3 m) of the storage area or entrance to the store
- keep packages on sealed or laminated hardwood or coated metal shelves free from rust or corrosion to avoid a harmful reaction in the event of a spill

- keep a space of at least 100 mm between the packages and the floor, ceiling or walls. Fitting a guarding system or raised shelving can assist with this
- keep suitable spill containment equipment close to the store which can be accessed quickly and used in the event of a spillage
- if opening packages, take them at least 3 m clear of the store. Reseal all packages before returning them to the store.

Temperature controls can be important in the safe handling and storage of organic peroxides. To avoid harmful reactions or decomposition of the organic peroxides due to temperature:

- determine any critical temperatures including any recommended maximum temperature. The label and SDS may provide this information. Otherwise, other sources should be consulted. Keep the store within the recommended temperature range for the different types of organic peroxides present and keep organic peroxides out of direct sunlight
- do not permit heating to be installed in the storage area.

If cooling or refrigeration is required to maintain the desired temperature in the storage area, expert advice should be obtained because air conditioners and unmodified refrigerators are potential ignition sources.

Further information on storage and handling of organic peroxides can be obtained from AS 2714: *The storage and handling of organic peroxides*.

Corrosives

Corrosive substances and mixtures can be either alkaline or acidic and these two categories are incompatible. Acids should never be stored with alkaline chemicals due to the potential for harmful reactions. Some reactions of acids and alkaline chemicals can be highly exothermic and rapidly generate large amounts of gas, causing an explosion risk.

Risks associated with storage and handling of corrosive substances and mixtures can be eliminated or minimised by observing the guidance in the following Australian Standards:

- AS 3780: The storage and handling of corrosive substances
- AS 1940: *The storage and handling of flammable and combustible liquids* (where the corrosive substance or mixture is also a flammable liquid or has a dangerous goods Subsidiary Risk of Class 3 (flammable liquid)
- AS/NZS 3833: The storage and handling of mixed classes of dangerous goods, in packages and intermediate bulk containers.

Eyewash and safety showers should be readily accessible where corrosives are handled or transferred.

Amendments

The model Code of Practice: *Managing the risks of hazardous chemicals in the workplace* has been amended several times since its publication in July 2012, including:

- a number of amendments agreed to in 2017 as part of a technical and usability review of the model Code
- updates made in 2020 and 2023 to reflect Australia's adoption of the 7th revised edition of the GHS
- changes made in 2021 to reflect the replacement of the National Industrial Chemicals Notification and Assessment Scheme by the Australian Industrial Chemicals Introduction Scheme.

The model Code underwent significant update in 2026 to:

- reflect the implementation of the *Workplace exposure limits for airborne contaminants*
- align with the model Codes of Practice *Preparation of safety data sheets for hazardous chemicals* and *Labelling of workplace hazardous chemicals*
- align with new guidance on air monitoring and the workplace exposure limits
- remove appendices that duplicate regulatory requirements or contain stand-alone information more appropriately accessed through the Safe Work Australia website
- provide additional information on the selection and use of respiratory protective equipment (RPE)
- introduce plain-language descriptions of GHS classifications, and
- improve clarity and useability.

The current version, dated November 2026, incorporates all of those amendments.