Managing Hazardous Chemicals

Core Body of Knowledge for the Generalist OHS Professional

Second Edition, 2023

17.1

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Managing Hazardous Chemicals

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Core Body of Knowledge for the Generalist OHS Professional

Managing Hazardous Chemicals

Abstract

Managing chemical hazards is an important yet challenging role for the generalist OHS professional. This *OHS Body of Knowledge* chapter provides an overview for a suite of chapters examining hazardous chemical management, the other chapters being *OHS BoK* 17.2 Health Effects of Hazardous Chemicals, 17.3 Dusts, Fumes and Fibres, and 17.4 Process Hazards (Chemical). This chapter introduces a systematic and systemic approach to managing chemicals in the workplace, starting with hazard identification entailing compilation of a chemical register, and examination of product information, including chemical labels and safety data sheets. Chemical risk assessment is discussed based on understanding the chemical hazard and the workplace potential for exposure, followed by a discussion of the hierarchy of hazard control approach to minimising exposure and risk mitigation. A brief discussion of product stewardship is followed by consideration of the implications for OHS practice, including comments on when generalist OHS professionals should seek advice from chemical safety specialists.

Keywords

hazardous chemical, dangerous goods, hazardous substances, GHS, OHS, chemical risk assessment, chemical health effects

Contextual reading

For context, readers should refer to *OHS Body of Knowledge* 1 Preliminaries, 2 Introduction and 3 The Generalist OHS Professional: International and Australian Perspectives.

Terminology

Depending on the jurisdiction and the organisation, Australian terminology refers to ‘Occupational Health and Safety’ (OHS), ‘Occupational Safety and Health’ (OSH) or ‘Work Health and Safety’ (WHS) interchangeably. In line with international practice, this publication uses OHS with the exception of specific reference to the Work Health and Safety (WHS) Act and related legislation.

Jurisdictional application

This chapter includes reference to Australian model work health and safety legislation. This is in line with the Australian national application of the *OHS Body of Knowledge*. Readers working in each legal jurisdictions should consider these references as examples and refer to the relevant legislation in their jurisdiction of operation.

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1 Introduction

In 2021, the International Labour Organization observed that:

> Workers around the world are facing a global health crisis due to occupational exposure to toxic chemicals. **Every year more than 1 billion workers are exposed to hazardous substances, including pollutants, dusts, vapours and fumes in their working environments.** Many of these workers lose their life following such exposures, succumbing to fatal diseases, cancers and poisonings, or from fatal injuries following fires or explosions. We must also consider the additional burden that workers and their families face from non-fatal injuries resulting in **disability, debilitating chronic diseases**, and other health sequela, that unfortunately in many cases remain invisible. **All of these deaths, injuries and illnesses are entirely preventable.** (ILO, 2021, p. v)

As indicated above, chemical hazards are a major ongoing concern in workplaces. In Australia, workers in some industries and specific workplaces have a higher risk of exposure, however, all workplaces have some exposures to chemicals. Australia has a robust (albeit complicated) set of legislation, regulations, codes of practice and information about chemical safety which makes it possible to manage the supply, storage, use and disposal of hazardous chemicals. Generalist occupational health and safety (OHS) professionals have a significant role in the management of hazardous chemicals, and this chapter will assist them in this role.

Hazardous chemicals in workplaces can create physical hazards such as fires or explosions that result in immediate injury to people and damage to property and the environment (e.g. the catastrophic 1984 chemical accident in Bhopal, India[1], or the 2020 explosion of an ammonium nitrate fertilizer warehouse in Beirut, Lebanon) and/or may cause slowly progressive, insidious damage to the health of workers and others (e.g. lung disease as a result of exposure to respirable crystalline silica[2]).

Despite these potential adverse experiences, years of evidence-informed law development and enforcement and rigorous chemical management have taught us that chemicals can be stored, handled and used safely. As OHS professionals, it is important to understand the basics of safe chemical management, and to know when you don’t know enough to follow legal requirements and to confidently reduce risks of chemical exposures.

[1] The magnitude of such events is demonstrated in *OHS BoK* 13 Managing Process Safety (Table 3), which lists 26 process safety disasters that resulted in a total of more than 5000 fatalities. For information about the Bhopal disaster, see Taylor (2014).

[2] See SWA (2021b) and *OHS BoK* 17.3 Dusts, Fumes and Fibres for information about the risks of respirable crystalline silica exposure associated with working with engineered stone.

To understand the hazards of chemicals in the workplace, OHS professionals need knowledge of the chemicals and how they cause damage. To control the risks associated with hazardous chemicals, a systematic and systemic approach throughout the lifecycle of the chemicals in a workplace is required which encompasses the following chemical management stages:

- *Hazard identification* – using chemical registers, chemical labels, safety data sheets and hazardous chemical databases (See section 5.4)
- *Risk assessment* – recognising that a hazard becomes a risk in the context of exposure and the factors that affect that exposure
- *Risk control* – applying the hierarchy of hazard control measures to use, storage, transport and disposal of chemicals, and ensuring emergency preparedness
- *Monitoring* – mitigating risk through evaluation of interventions using workplace and health monitoring, and associated action based on monitoring outcomes
- *Communication* – acquiring information from chemical developers and users, and providing information to those making decisions about chemical risks
- *Facilitating product stewardship* – managing product information and advice geared to reducing OHS and environmental impacts.

This chapter is the first in a suite of *OHS Body of Knowledge* chapters on chemical hazards, risks and controls:

- *OHS BoK* 17.1 Managing Hazardous Chemicals (this chapter) provides a general overview of chemical hazards and how to control the associated risks
- *OHS BoK* 17.2 Health Effects of Hazardous Chemicals addresses the toxicological effects of chemicals on the health of humans
- *OHS BoK* 17.3 Dusts, Fumes and Fibres examines the specific hazards associated with exposure to dust, fumes and fibres
- *OHS BoK* 17.4 Process Hazards (Chemical) focuses on control of chemical reactivity that may cause immediate damage to people, property and the environment.

The content of these chapters assumes that the generalist OHS professional has sufficient knowledge of chemical states, structure and reactivity,[3] and of the biological systems of the human body,[4] to understand chemical hazards and how they may cause damage.

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[3] *OHS BoK* 14 Foundation Science outlines the basic science knowledge that should inform generalist OHS professional practice.

[4] *OHS BoK* 7 The Human as a Biological System highlights the potential systemic effects of chemicals on the human body.

This chapter draws on, and updates, an earlier edition. After providing some relevant definitions below, the chapter addresses the historical context in section 2. It then considers relevant legislation (section 3) and a brief overview of chemical hazard classification (section 4). Sections 5 to 8 follow the chemical management lifecycle approach through hazard identification, risk assessment and control (including mitigation of risk), and product stewardship. The chapter concludes with a discussion of the implications for OHS practice in section 9, and a summary.

1.1 Definitions

Safe Work Australia defines chemicals as any substance that has a defined composition (SWA, 2032a).

This definition includes:

- Chemical elements, chemical compounds , chemical mixtures, and proprietary chemical products, hazardous chemicals or hazardous substances as classified by the Globally Harmonised System for classification of chemicals (UNECE, 2021)
- Dangerous goods (DG) as defined by the National Transport Commission in the Australian Code for the Transport of Chemicals by Road and Rail (NTC, 2020)[5]
- Poisons as defined in the Therapeutic Goods Administration, The Poisons Standard (TGA, 2022)
- Agricultural and veterinary chemicals
- Industrial chemicals
- Articles which contain, produce or release chemical substances.

Because the variety of definitions can cause confusion, Safe Work Australia has joined the United Nations in harmonising the definitions and classification of hazardous chemicals for labelling, storage and use in workplaces.

In this chapter, aligned with Safe Work Australia's definition, the term 'chemicals' is used in general and 'hazardous chemicals' used when referring to GHS or Dangerous Goods classification of chemicals.

[5] The requirements for storage and transport of Dangerous Goods are not addressed in this chapter.

2 Historical context

As long as humans have been mining and smelting metals, or applying dung to enhance crop yield, or brewing tea to treat ailments, they have been exposed to chemicals. Although chemicals are useful and, in fact, essential for many workplace and domestic processes, they can have immediate disastrous impacts as a result of their reactivity (e.g. fire, explosion or other acute health effects such as acid burns) and/or chronic health effects after repeated exposures (e.g. cancer, lung disease).[6]

The reactive and toxic effects of hazardous chemicals have resulted in two trajectories of legislation and regulation focused on the use, storage, transport, disposal and treatment of, and communication about, chemicals. Historical perspectives on chemical disasters and the resultant legislation and regulation are included in chapters *OHS BoK* 13 Managing Process Safety (2019) and 17.4 Process Hazards (Chemical). *OHS BoK* Chapter 17.3 Dusts, Fumes and Fibres describes the development of knowledge and regulation related to chemicals responsible for long-term health effects. Modern approaches to managing hazardous chemicals in the workplace reflect both these development streams.

3 Legislation

The management of chemicals is subject to a complex regulatory regime of Commonwealth and State legislation, which includes regulations related to:

- New or imported chemicals
- Explosives
- Dangerous goods in storage and transport
- Poisons, pharmaceuticals and narcotics
- Agricultural and veterinary chemicals
- **Hazardous chemicals in the workplace**
- Health monitoring of people exposed to hazardous chemicals
- Hazardous substances produced from the use of articles
- Major hazard facilities which produce, use or store hazardous chemicals above certain quantities
- Emergency preparedness including labelling of chemical storage
- Hazardous waste and chemicals hazardous to the environment.

[6] Sometimes there are long-term effects from a single exposure, but this is less common.

For the generalist OHS professional, it is important to understand how to manage chemicals in the workplace. For that purpose, this section focuses on the obligations under the national model work health and safety regulations.

The model *Work Health and Safety Act 2011* (WHSA ss 22-25; see SWA, 2022a) places extensive obligations on persons who design, manufacture, import or supply chemicals that are used or could be used in the workplace. An OHS professional who finds themselves working for such an organisation (e.g. in the chemical industry) should be an expert in chemical safety and/or find assistance from a professional who is.

In addition, every PCBU (Person Conducting a Business or Undertaking) has obligations under the model *Work Health and Safety Regulations* (WHSR; see SWA, 2022b) with respect to hazardous chemicals. These include:

- Keeping a register, manifest and placarding hazardous chemicals
- Providing information about the materials used through labelling of chemical containers and providing access to safety data sheets (SDSs)
- Managing the risk of storage, use and disposal of chemicals in the workplace[7]
- Ensure monitoring for airborne contaminants with mandated exposure limits
- Ensure that no person at the workplace is exposed to a chemical that exceeds the exposure standard for that chemical
- Health monitoring for persons with exposure to specific known hazardous chemical
- Managing the risk of adverse events such as spills, fires and explosions, and provision of safety equipment and first aid
- Complying with other chemical regulations such as ADG Code (WHSR Part 7.1; SWA, 2022b), Major Hazard Facility regulations, EPA regulations, etc.

4 Chemical hazard classification

As indicated above, the Model WHS legislation imposes responsibility on chemical manufacturers and importers to register any new or imported substances, to classify the substances as to their hazards, and to provide this information on labels and SDS. The Model WHS Regulations impose responsibilities on PCBUs to understand the risks of their chemical; as a minimum by accessing the information on SDS and labels.

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[7] See *OHS BoK* 17.3 Dusts, Fumes and Fibres for information about exposure limits.

There is high potential for confusion in identifying chemicals. Chemical nomenclature is very precise; each chemical has a unique identifying name and number assigned by the International Union of Pure and Applied Chemistry (IUPAC).[8] However, many chemicals also have common names (e.g. sodium chloride is also known as table salt) and chemical products may be similar mixtures with different product names (e.g. sodium hypochlorite is the main chemical in cleaning products White King®[9] and Domestos®[10]).

The Globally Harmonized System of Classification and Labelling of Chemicals (GHS) (UNECE, 2021a,b) is a standardised approach to chemical classification and labelling that was created by the United Nations in consultation with most international agencies responsible for controlling chemical safety (e.g. Health and Safety Executive (HSE) (UK), Occupational Health and Safety Administration (OSHA) (US), National Institute for Occupational Safety and Health (NIOSH) (US), Mine Safety and Health Administration (US) (MSHA), ACGIH® (US). The GHS covers all hazardous chemicals, sets out the criteria used to determine if a chemical is hazardous, and is used for preparing labels and SDSs (SWA, 2020a).

The third revised edition of the GHS was implemented in Australia in 2012 with a five-year transition period (SWA, 2020a). To keep in step with trading partners, Australia has since transitioned to the seventh revised edition of the GHS[11] and, from January 2023, only GHS 7 criteria can be used to classify and label chemicals in Australia (SWA, 2023).

Although control of hazardous chemicals attracts additional regulations and codes of practice relating to storage, transport and disposal of chemicals, the GHS, chemical labels and SDSs are the basis for chemical hazard communication regulation in Australia.

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[8] See https://iupac.org/what-we-do/nomenclature

[9] See SDS for White King Bleach: https://www.abcoe.com.au/documents/White_King_Bleach_Bulk.pdf

[10] See SDS for Domestos: https://s3-ap-southeast-2.amazonaws.com/wc-prod-pim/Asset_Documents/Domestos%20Regular%20SDS.pdf

[11] "The two-year transition to GHS 7 began on 1 January 2021 [and] finished on 31 December 2022, giving manufacturers and importers time to implement the updated system" (SWA, 2023b).

5 Hazard identification

5.1 Chemical register

An important element in the control of chemical hazards is knowing what materials are present in the workplace. As such it is necessary to keep a register of chemicals; this may also be referred to as a manifest[12] or an inventory but, as these names have specific meaning in regulations, this chapter will refer to a chemical register.

A chemical register is a list of all the hazardous chemicals used at a workplace. It is essential for any hazardous chemicals to be on the register (SWA, 2020d); however, to avoid confusion, all[13] chemical in the workplace should be listed in a broader inventory. (Otherwise, it may not be clear whether the absence of a material on the register is indicative of an omission or a risk assessment finding that it was not hazardous.)

The chemical register should clearly identify the name of the chemical, and the product names used in the workplace, and chemical constituents. Also, it should include any relevant hazard codes, a link to the SDS, quantity, location of storage, and intended use at the workplace (SWA, 2019). Figure 1 is an example template of a chemical register.

	Hazardous Chemical Register				
Company	Worksite:		Date last reviewed:		
(SDS has an expiry date of 5 years)			Contact person:		
Name on the Label	Hazardous Chemical	Issue date of SDS; link to SDS (SDS has an expiry date of 5 years)	Quantity	Location	Comments
Example: EthoSolve	Ethanol	19/02/2019	10L	Flammable liquid cabinet, Storage Room 1	Solvent for paints

Figure 1: Hazardous chemical register example template (SWA, 2019)

12 “A manifest is different from a register…[It] 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.” (SWA, 2020d, p. 14)

13 Chemical materials that are in transit and consumer products are exempt (SWA, 2019).

Information for identifying chemical hazards may be found in chemical labels, SDS and hazardous chemical databases.

5.2 Chemical labels

In the past, chemical labelling requirements in Australia focused on the intended use of the material.[14] Since 2021, as the focus moved to workplace communication, chemical labelling has been unified by GHS 7, which, along with the WHS Regulations (SWA, 2022b), has provided consistency in classification and labelling of workplace hazardous materials (see SWA, 2020c).

From the perspective of OHS professionals and workplace users of chemicals, important label components under the GHS (in addition to providing the name and supplier of the material) include signal words, hazard and precautionary statements, and hazard pictograms. As described by Safe Work Australia (2020):

> **Signal words** are used to indicate the relative level of severity of a hazard. The GHS uses 'Danger' and 'Warning' as signal words. 'Danger' is used for a more severe or significant hazard, while 'Warning' is used for the less severe hazards.
>
> **Hazard statements** describe the nature of a hazard, including the degree of hazard, where appropriate. A unique hazard statement is assigned to each hazard class and category. … All relevant hazard statements must appear on the label.
>
> **Precautionary statements** describe the recommended measures that should be taken to minimise or prevent adverse effects resulting from exposure to, or improper storage or handling of, a hazardous chemical. Precautionary statements are assigned to each hazard class and category. Precautionary statements are separated into five categories:
>
> - *Prevention statements* refer to precautions to be taken to prevent an accident or exposure.
> - *Response statements* refer to instructions in case of an accident.
> - *Storage statements* refer to instructions for safe storage of the chemical.
> - *Disposal statements* refer to appropriate disposal instructions.
> - *General statements* are for use as appropriate.
>
> **Hazard pictograms.** The GHS specifies nine hazard pictograms, having regard to physical, health and environmental hazards [and these] must be included on the label in most cases. (SWA, 2020c, pp. 15-16)

There are special instructions for labelling pipe work, small containers, research chemicals, materials in transit, and wastes. Where appropriate, "class labels required for the transport

[14] In certain circumstances, chemical labels also need to comply with the *Australian Code for the Transport of Dangerous Goods by Road & Rail* (NTC, 2020) and/or the *Poisons Standard* (Section 1 Labels) (TGA, 2022*).* Dangerous Goods (DG) labels are required on the exterior of transport vehicles, while the GHS incorporates DG symbols on internal labels. Poisons continue to be separately defined in Australian State legislation under the Poison *Standard* produced the Therapeutic Goods Administration (TGA, 2022),. Generally, poisons regulations apply to consumer products.

of dangerous goods as per the *Australian Code for the Transport of Dangerous Goods by Road and Rail* (the ADG Code) may be used instead of the relevant hazard pictograms specified in the GHS" (SWA, 2020c, p. 16).

5.3 Safety data sheets

A safety data sheet (SDS) is a document provided by the chemical manufacturer, importer or supplier[15] that summarises the material's hazards and provides instructions for safe use, storage, disposal, personal protection and first aid. The hazards described in an SDS and on chemical labels relate to the chemical properties and impact of the material on human health and the environment. These hazards are defined and classified according to the GHS.

As explained by Safe Work Australia (2020e, p. 6):

> A safety data sheet (SDS), previously called a Material Safety Data Sheet (MSDS), is a document that provides critical information about hazardous chemicals. For example, an SDS includes information on:
>
> - the supplier contact information
> - the chemical's identity, ingredients and chemical properties
> - health, physical and environmental hazards, including hazard symbols and precautionary statements
> - first aid instructions
> - safe handling and storage procedures
> - emergency procedures
> - disposal considerations
>
> An SDS is an important tool for assessing and managing the risks associated with the use of hazardous chemicals in workplaces.

In addition to the legislative requirement for manufacturers and importers to prepare and supply an SDS for substances classified as a hazardous chemical, every PCBU must provide information to the workplace about hazardous materials (WHSR Part 7.1; SWA, 2022b).[16] To comply with the WHS Regulations, an SDS must address specified criteria for content and layout (see SWA 2022b, Schedule 7). While an expert is likely to be needed to define the classification of a given material and prepare a product SDS, it is important for all OHS professionals and everyone in the workplace using chemicals to recognise and understand the symbols used on chemical labels and SDSs, and their meanings (Figure 2).

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[15] If a business generates the material, it must produce and supply the SDS. Also, importers must supply a compliant SDS regardless of the origin of the material.

[16] Refer to Safe Work Australia (SWA, 2020e) for exceptions.

GHS01—Exploding bomb
Explosion, fire, blast or projection hazard.

GHS02—Flame
Flammable liquids, vapour, solids and gases; including self-heating and self-igniting substances.

GHS01—Flame over circle
Oxidising liquids, solids and gases, may cause or intensify fire.

GHS04—Gas cylinder
Gases under pressure.

GHS05—Corrosion
Corrosive chemicals, may cause severe skin and eye damage and may be corrosive to metals.

GHS06—Skull and crossbones
Fatal or toxic if swallowed, inhaled or in contact with skin.

GHS07—Exclamation mark
Low level toxicity. This includes respiratory, skin sensitisers and chemicals harmful if swallowed, inhaled or in contact with skin.

GHS08—Health *Hazard*
Chronic health hazards; this includes aspiratory and respiratory hazards, carcinogenicity, mutagenicity and reproductive toxicology.

GHS09—Environment
Hazardous to aquatic life and the environment.

Figure 2: GHS pictograms and their meanings (SWA, n.d.)

SDSs and chemical labels should be the initial sources of information on chemical hazards. They should inform any risk assessment, assist in making decisions about storage and transport, and be used as a starting point for considering handling and disposal processes. However, they must be used in addition to local information where potential exposure is assessed before finalising decisions on use. It is important to be aware that:

- Information about health effects and toxicity in an SDS may be incomplete due to lack of information about the effects of repeated or long-term use of a chemical. Some SDSs may only provide data based on short-term animal studies or simply state that there is no information on long-term effects.
- An SDS is meant to describe the hazard for a product as a whole; however, if a chemical mixture is not tested, the SDS may only provide hazard information pertaining to selected ingredients without addressing interactions among ingredients.
- The authors of a chemical supplier's SDS are unlikely to be aware of all possible uses of their materials, meaning that the precautions for use cited in an SDS may not be appropriate for specific workplaces.
- SDSs and chemical labels are not risk assessments because they do not describe the exposure to the material in the specific workplace. However, they must be used as part of the risk assessment.

5.4 Hazardous chemical databases

To supplement the information provided in an SDS, detailed information on hazardous chemicals is available from databases such as Safe Work Australia's *Hazardous Chemicals Information System* (HCIS).[17] The HCIS is a searchable database of chemical identification, hazard classifications, hazard statements, pictograms and signal words, as well as workplace exposure standard (WES; soon to be called WEL (Workplace Exposure Level)) information (SWA, 2021a). This information is usually available in an SDS, but the database is useful for checking the accuracy of an SDS and for suppliers who must compile SDSs. Safe Work Australia recognises the limitations of the HCIS database and "does not make any representation or warranty about the accuracy, reliability, currency or completeness of any material contained within HCIS" (SWA, 2021a).

6 Risk assessment

While chemical hazard identification is about recognising the chemical as a potential source of harm, assessing the risk requires knowledge of how the chemical behaves, how it might cause harm and how humans may be exposed to it through its use in the workplace.[18]

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[17] Available at http://hcis.safeworkaustralia.gov.au/

[18] See *OHS BoK* 17.2 Health Effects of Hazardous Chemicals and 17.3 Dusts, Fumes and Fibres.

Chemical risk assessment is more than assigning a severity and likelihood rating from a table or comparing a measured exposure level with an exposure standard. A more comprehensive risk assessment report is likely to be needed.

In its most simplistic application, chemical risk assessment involves knowledge of how the chemical causes harm (its toxicology) and how workers may be exposed to the material through its use (or misuse) in the workplace. This information is used to determine whether there is potential for a worker to be exposed to quantities of chemical that could adversely impact their health. For some chemicals the exposure below which nearly all workers may be repeatedly exposed without significant health effects is expressed in the workplace exposure limit (formerly called the workplace exposure standard or the TLV).[19] The WEL or WES can be presented as a Peak not to be exceeded, a Short Term Exposure Limit (STEL) and/or a Time Weighted Average (TWA) usually averaged over an 8 hr shift. Not all chemicals have a defined exposure standard and calculations may need to be done to determine safe levels of exposure; this may require a specialist in occupational hygiene to do the calculations. Once the tasks with potential for exposure are known and amounts of exposure estimated, the risk assessment can estimate the likelihood that combined exposures may cause ill health. This information is then used to determine the appropriate controls to reduce exposure to an acceptable level, as well as any associated training requirements.

If there is evidence of significant existing or future worker exposure to a hazardous chemical (via inhalation, skin or eye contact or, less likely, ingestion) advice given by the OHS professional may go straight to controlling the exposure (section 7) through task modification or engineering controls, etc. This will require consultation with workers who understand the tasks, and/or assistance from specialists who may be able to design out the exposures.

6.1 Risk factors for reactive chemicals

As explained in *OHS BoK* 17.4 Process Hazards (Chemical), risk assessment for reactive chemicals usually focuses on preventing conditions that will cause the chemicals to react. These chemicals are likely to be labelled with the GHS pictograms of Explosive, Flammable, Oxidising Agent, and/or Gas under Pressure. Reactions can be quite catastrophic. Prevention of reacting conditions requires knowledge of the:

- Nature of the chemical reactivity of the substance (e.g. flammable, explosive, oxidising, corrosive, gas under pressure, combination of incompatible substances)
- Environmental factors that may influence reactivity (e.g. sources of ignition, storage

[19] See the HCIS at www.hcis.safeworkaustralia.gov.au/ for current WES values. See *OHS BoK* 17.3 Dusts, Fumes and Fibres for an explanation of exposure standards.

conditions)

- Operating factors (e.g. temperatures, pressures, transfer methods)
- Potential consequences (e.g. fire, explosion, acute toxic release).

6.2 Risk factors for chemicals with adverse health effects

Risk assessment for chemicals with known or possible adverse health effects focuses on the potential for human exposure at an amount that is likely to cause harm. This requires an understanding of the hazardous nature of the material (i.e. its toxicity), how much is needed to cause harm (i.e. its dose response or quantity over time) and the potential for humans to be exposed. These factors are discussed in more detail in *OHS BoK* 17.2 Health Effects of Hazardous Chemicals and 17.3 Dusts, Fumes and Fibres.

The risk of harm or damage from chemical exposure is multifactorial, and is dependent on the:

- Physical/chemical state of the material
- Toxicity of the material and dose-response relationship
- Route of exposure (inhalation, skin or eye contact or ingestion)
- Extent of exposure (minutes, hours or working lifetime)
- Nature of the task or activity involving the chemical (does it require physical activity and heavy breathing, skin contact, etc
- Workplace environment (heat, ventilation, confined space, etc)
- Individual worker (individual susceptibilities, behaviours, etc).

6.2.1 Physical/chemical state

Is the material a gas, solid or liquid? Does it have a vapour pressure or change state? The physical state of a chemical may govern the extent of worker exposure. For example, solid, liquid or gaseous lead exposures can result in more than one exposure pathway (e.g. physical contact with skin and/or fume inhalation). Liquids have the greatest potential for chemical intake via the skin. Gases, vapours and aerosols have the greatest potential for chemical intake via inhalation.

6.2.2 Toxicity and dose-response relationship

The toxicity of chemicals is determined by their chemical nature, the particular physiologic mechanisms of action in humans, and the types of cells/tissues/system(s) of the body they affect. An increase in the amount of chemical intake into the body (the dose) will generally cause an increase in the biological response and an increase in the number of individuals affected. However, sensitivity to chemicals can vary among individuals; while some may be resistant to specific exposures, others, such as pregnant women or older workers with multiple morbidities, may be quite sensitive, which should be a consideration in risk assessment. "The characteristics of exposure and the spectrum of effects come together in a correlative relationship customarily referred to as the *dose-response relationship*" (Eaton & Gilbert, 2015).[20]

The GHS signal words and hazard statements provide an indication of toxicity and health effects from exposure to specific chemicals. For the generalist OHS professional, the use of the GHS effectively removes the need to consider the dose-response relationship as part of chemical risk assessment as it uses dose-response data to determine the classification of the chemical.

6.2.3 Route of exposure

The three main routes of worker exposure, and subsequent entry of toxins to the body[21] are:

- *Inhalation.* When exposed to an airborne chemical, chemical gases travel through the lungs to the alveoli (the gas /blood interchange area) where they may be absorbed based on their solubility. For particulate matter, the human respiratory system allows entry of particles less than approximately 100 micrometres via the mouth or nose; these particles are usually deposited and cleared via mucus and swallowed. As the airways to the lungs decrease in size, there is deposition and clearing of various particle sizes until the alveoli are reached by particles less than 10 micrometres. Once in the alveoli, particles may be absorbed directly into the blood stream, or they may be exhaled. Size and solubility are two properties of particles that most determine transfer of their constituents from the alveoli to the bloodstream.[22]
- *Dermal or eye contact.* Skin and/or eye contact may result in irritation. The skin may selectively absorb some organic solvents and some insecticides. The barrier property of intact skin generally prevents the absorption of water-soluble substances and many inorganic substances. In the case of liquid mixtures, there may be a complex interaction of skin and chemical, with one chemical component providing a dermal absorption pathway for a toxic chemical; some topical pharmaceuticals take advantage of this. Some organophosphate insecticides can rapidly permeate through the skin resulting in nerve agent effects.
- *Ingestion.* Substances reach the gut when work-dirtied fingers are used to handle food, or in the clearance of inhaled particles from the tube-like passages that carry

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[20] The dose-response relationship is explained in *OHS BoK* 17.2 Health Effects of Hazardous Chemicals. Variations in individual responses to exposure are discussed in *OHS BoK* 17.3 with reference to dusts, fumes and fibres.

[21] See *OHS Bok* 17.2 Health Effects of Hazardous Chemicals.

[22] *OHS BoK* 17.3 Dusts, Fumes and Fibres describes the action of airborne chemicals on the human body.

inhaled air into the lungs. Depending on the nature of the substance, some will be absorbed into the blood from the gut; the rest will be lost from the body in faeces.

6.2.4 Extent of exposure

Concentration, frequency and duration of exposure will affect the risk of harm to workers. Exposures that influence the magnitude of potential exposure may be:

- An occasional one-off exposure
- Continuous exposure over a working lifetime
- Occurring only during maintenance or when spilled, will.

The components of a chemical exposure may be assessed in one or more of:

- Inspection and observation
- Incident reports or first aid treatments
- Exposure monitoring (e.g. air monitoring)
- Health monitoring

Inspection and observation

'Walk-through' inspections, formal workplace inspections, and observation of work tasks can provide information on the risk associated with use of chemicals. At the most basic level, visible contamination, spills and storage issues may indicate the potential for inhalation, skin contact, or hazardous interactions such as contact between flammable materials and sources of ignition. Also, inspections and maintenance records can provide relevant information on adequacy of any already implemented controls (e.g. ventilation) (SWA, 2020d).

Although an odour may indicate the presence of a chemical in the air, there are many situations in which odour is not a good indicator of risk. Some chemicals are readily identified before they are considered toxic (e.g. ammonia); some have little or no odour (e.g. carbon monoxide[23]); and some such as hydrogen sulfide can cause olfactory fatigue where frequent exposure reduces the ability to detect high concentrations; death can result.

Incident reports and first aid treatments

Reports of incidents (e.g. fires or spills) and complaints of health effects (e.g. skin or eye irritation or respiratory symptoms) provide information vital for chemical hazard identification. Also, they are key sources of information about the level of risk and the adequacy and effectiveness of controls. Reports and complaints need to be regularly reviewed to ensure early awareness of possible issues.

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[23] See *OHS BoK* 17.2 Effects of Hazardous Chemicals for an example of the insidious effects of carbon monoxide poisoning.

Air monitoring

Where there is evidence of potential or actual worker exposure to hazardous chemicals or potential for release of such chemicals into the atmosphere, immediate actions to control the exposure may be required. It may be appropriate to monitor the extent of exposure using instrumentation.

Air monitoring requires a good understanding of the tasks, extent and source of any leaks and likely chemicals causing the exposures so that an appropriate sampling strategy can be developed. Any amounts detected during sampling will be compared to the appropriate WES/ WEL. When comparing the measured amounts to the WES, it is worth remembering that exposure should always be maintained as far as reasonably practicable, as exposure standard "do not represent a fine dividing line between a healthy and unhealthy work environment" (SWA, 2020d, p. 13). For further discussion about interpreting air monitoring data, see *OHS BoK* 17.3 Dust, Fumes and Fibres.

Monitoring data should be shared with those involved in the monitoring and those potentially exposed; if appropriate, de-identified results should be shared with health and safety representatives. Any OHS professional conducting even basic monitoring should be willing and able to explain the meaning of a monitoring result to a person being tested. While it is appropriate for the suitably qualified and experienced generalist OHS professional to carry out basic monitoring, sophisticated monitoring and interpretation of results requires specialist occupational hygiene knowledge.[24]

Health monitoring

Health monitoring is "monitoring the person to identify changes in the person's health status because of exposure to certain substances" (WHSR s 5, SWA, 2022b). Health monitoring programs evaluate the effects of chemical exposure from all routes – inhalation, skin and eye exposure, ingestion and injection – and may consist of biological, biochemical or biological effect monitoring, as well as specific tests to determine the health status of workers and extent of disease (Manno et al., 2010). Health monitoring may be proactive (i.e. before workers develop symptoms or irreversible damage) or reactive, and should proceed from a risk assessment. While individual results of biological monitoring and health monitoring are confidential and therefore should be shared only with the individual, summarised results should be communicated to those involved in making decisions about risk (Manno et al., 2010). Your state may also require you to report incidents and exposures to hazardous substances.

[24] *OHS BoK* 17.3 Dusts, Fumes and Fibres provides an introduction to air monitoring strategies.

The type and frequency of health monitoring depends on a range of factors, including:

- Regulatory requirements (some specific chemicals such as lead and carcinogens, have health monitoring requirements)
- Nature and type of chemical(s)
- Level and duration of exposure and route of entry
- Effectiveness of controls (SWA, 2020b).

Health monitoring programs must be overseen by a registered medical practitioner or occupational physician as there are technical, ethical and confidentiality issues associated with collecting and communicating about medical information. (WHSR s 371; SWA, 2022b).[25]

6.2.5 Task or activity

Aspects of a work task or activity should be taken into consideration when assessing risk, particularly aspects that may impact the level of exposure.

Physical activity may influence exposure. Heavy physical labour will make a worker breathe harder, resulting in more intake of concurrent chemical exposure. Cleaning operations or spills cleanup may result in physical contact with materials or put the chemical material into the breathing zone. When conducting a risk assessment it is important to observe all tasks and discuss with workers how the tasks are completed.

With respect to chemical exposures, some processes or techniques may result in higher exposures or multiple concurrent chemical exposures. For example, in agricultural situations, there is likely to be a higher risk of chemical exposure associated with dispersive use of a spray application for a pesticide than application via direct contact with the targeted plant. Exposure to two or more chemicals concurrently creates the potential for them to react ‘synergistically;’ that is, the health impacts of the two chemicals together are greater than that of the individual chemicals alone, particularly if the chemicals effect the same target organ (e.g. the respiratory system). The Canadian Centre for Occupational Health and Safety (CCOHS, 2004) explained that synergism can occur when a chemical either inhibits or accelerates an enzyme function to cause a greater biological impact, and provided the following examples:

> (a) Carbon tetrachloride and ethanol (drinking alcohol) are individually toxic to the liver, but together they produce much more liver injury than the sum of their individual effects on the liver.

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[25] See *OHS BoK* 17.3 Dusts, Fumes and Fibres and 35 Mitigation of Health Impacts for further details on health monitoring.

(b) A much higher incidence of lung cancer results from occupational exposure to asbestos in smokers compared to exposed non-smokers.

Other types of chemical interaction include antagonism, where one chemical exposure reduces the impact of a concurrent exposure, and potentiation where non-work exposures make the work exposure worse; this may occur with some pharmaceuticals.[26].

It is worth remembering that SDS information cannot specifically address local use patterns and tasks, or aspects of worker activity. Knowledge of specific work circumstances must be obtained and considered in the associated work risk assessment; this may require experienced observation or other specialist input.

6.2.6 Workplace environment

Exposure to a hazardous chemical may be impacted by a range of factors in the workplace environment that may vary with the season, maintenance periods or other work activities in the area; for example:

- Environmental conditions such as temperature, sunlight, air flow and humidity
- Sources of ignition
- Potential interaction with nearby processes or incompatible chemicals.

6.2.7 Worker

A worker's exposure to a chemical may vary depending on their role in a task or activity, the way they do their job, and the appropriateness, condition and use of personal protective equipment (PPE). As a result, the impact of the exposure may vary based on these individual susceptibility factors:

- Experience, training, skills and behaviours
- Smoking, which has been shown to exacerbate the action of some substances (e.g. asbestos exposure)
- Alcohol consumption, which may compromise liver function and thus detoxification of the hazardous substance, or change worker behaviour
- Use of medications and drugs

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[26] **Antagonism** – Antagonism is the opposite of synergism. It is the situation where the combined effect of two or more compounds is less toxic than the individual effects. **Potentiation** results when one exposure that does not normally have a toxic effect is added to another substance, making the second chemical much more toxic. This might happen with interaction with prescription drugs. (CCOHS, 2004)

- General health status including preexisting disease, pregnancy and genetic diseases.[27]

The impact of these individual susceptibilities on exposure and response to substances may not be readily apparent and may need the assistance of an experienced occupational health practitioner to understand.

7 Control of chemical hazards

As with all risk-management activities, control of chemical hazards is achieved through the development and implementation of controls, and the ongoing monitoring of their effectiveness. The WHS Regulations (SWA, 2022b) include a chapter on hazardous chemicals, which details the processes required to control chemical risk in a workplace; however, legislated requirements should be considered a minimum standard.[28] This section reviews the hierarchy of controls as it applies to prevention of exposure to chemicals, highlighting the importance of evaluating the effectiveness of controls and taking action to mitigate the impact should a chemical incident or exposure occur.

7.1 Priorities for control action

Chemical hazard control aligns well with the hierarchy of control. However, unless the hazardous chemical is eliminated, a 'package' of controls will be required to minimise the residual risk and to implement a strong sequence of barriers and defenses to ensure that the controls remain effective.[29] Figure 3 depicts how the hierarchy of control measures relates to control of chemical hazards.[30] This same approach can be applied to prevention of exposure and when responding to chemical emergencies such spills and fires.

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[27] See *OHS Bok* 17.2 Health Effects of Hazardous Chemicals.

[28] While most states and territories have adopted the Model WHS Regulations, there may be additional requirements on a state by state basis. Various regulators provide a great deal more regulation, information, guidance, and mandatory codes of practice for some hazardous chemicals.

[29] See *OHS BoK* 34.1 Prevention and Intervention.

[30] There is the added requirement of controlling the potential hazards associated with responding to chemical emergencies (e.g. spills and fires) or when monitoring data indicates excessive exposure. Information on control is usually included in an SDS, but this generic information must be interpreted to develop actions specific to the situation.

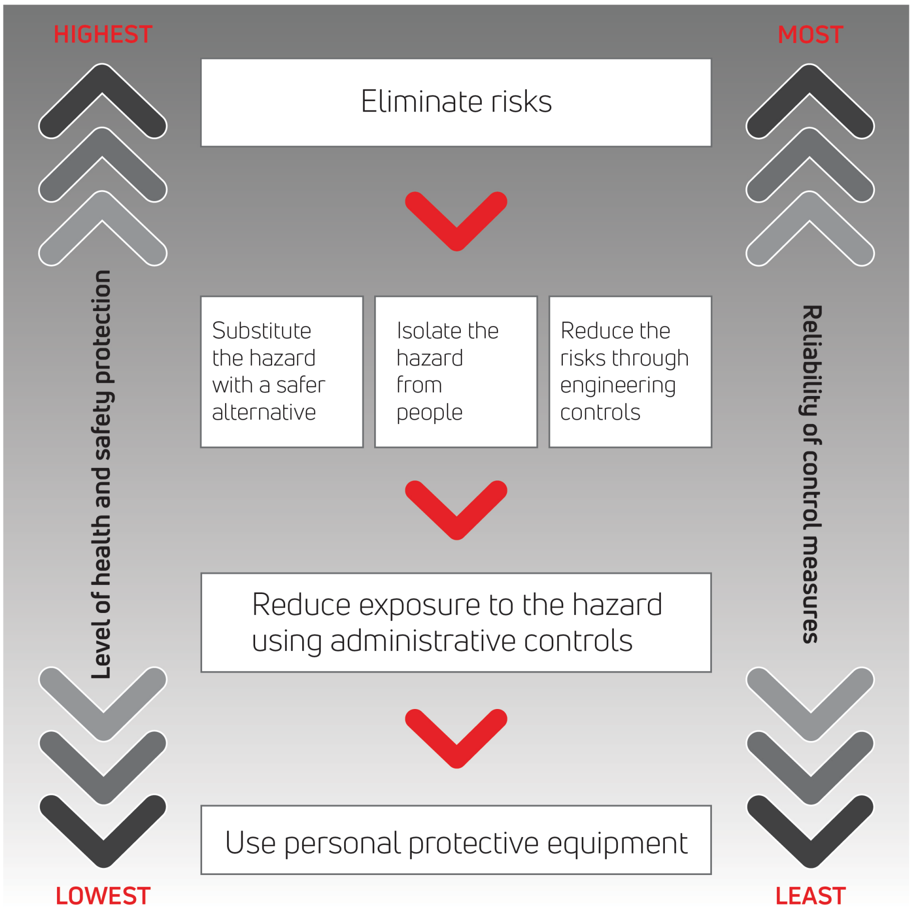

Figure 3: Hierarchy of control measures (SWA, 2018, p. 19)

Elimination

The most effective and reliable controls are those that result in elimination of the hazardous chemical not just in the workplace in question but through modification of the work process and in subsequent product use.

In advising on elimination of a manufacturing process using a hazardous substance by ceasing manufacturing at one site, it is important that moving to a less well-equipped workplace in another suburb or overseas is not seen as an option. Such action would give the appearance of elimination in one place but create a hazard elsewhere.

Substitution

Substitution of a hazardous chemical with a less hazardous one is the next control of choice; however, care must be taken to ensure that the substituted chemical does not introduce new hazards. In addition, substitution may involve using the chemical in a less-hazardous form or process (e.g. use of chemical in a pellet form rather than as a dust).

Isolation

Isolation of a hazardous chemical in time or space from those potentially exposed can be an effective means of control (e.g. locating people in a protected control room, enclosing the process in vessels or pipes, installing a buffer area around a chemical reactor, using the material when people are not in the vicinity).

Engineering controls

Engineering controls typically reduce exposure at the source (e.g. by local exhaust ventilation). Prevention of uncontrolled releases may be achieved using strategies such as quantity reduction, segregation, secure storage, and temperature control. The ongoing integrity of engineering controls usually requires introduction of administrative controls such as regular testing and maintenance.

In a large complex workplace, design of controls needs integration across processes lest what suits one process interferes with another. For example, there is increased risk when a process is altered or speeded-up and the workplace ventilation system needs modifying from its original design.

Administrative controls

Generally, administrative controls are required to supplement and coordinate higher-level controls. Administrative controls include work procedures and training of workers and their managers in the safe operation of the equipment. Preventive maintenance is important in preventing uncontrolled releases and ensuring engineering controls function as designed. Work procedures may need to be developed to ensure that a given job can be done safely. Such procedures would include any safe-handling procedures, special storage instructions, and instruction for uses in confined spaces. Training in safe, efficient and effective production is needed for all workers, and for supervisors who oversee production. Training must include standard operating procedures but also what to do when unexpected things happen.

Personal protective equipment

Personal protective equipment (PPE) is an important element in controlling risk associated with chemicals. PPE may be required to reduce exposure to chemicals absorbed through respiration or skin or eye contact, especially during unexpected events. Specialist knowledge may be required to ensure selection of the correct type of PPE for a specific chemical or task.

Selection of gloves for protection against chemicals absorbed through the skin requires reference to chemical resistance charts or databases and consideration of the potential for chemical permeation, penetration and degradation of the PPE. Most PPE providers and manufacturers have technical experts available to assist with correct glove selection. In some situations, chemically resistant safety footwear is required.

Inappropriate or poorly maintained PPE can itself act as a source of chemical exposure (e.g. contaminated gloves can be a source of ongoing exposure through persistent permeation or occlusion of the chemical inside the gloves).

While it would be expected that the risk associated with tasks such as decanting of chemicals would be controlled through enclosure or other engineering controls, some chemical-handling tasks may require eye protection. Depending on the task, this may be safety goggles or full-face protection.

There is a wide range of PPE for respiratory protection. Australian Standards provide information on appropriate selection of respirators but interpreting these standards and selecting the appropriate respiratory protection require specialist knowledge. Fitting, maintenance and user training are especially important for respiratory protection. There are internationally recognised fit-testing programs available to support any PPE respiratory program onsite.[31]

For more information on chemical hazard control, see *Managing Risks of Hazardous Substances in the Workplace: Code of Practice* (SWA, 2020d) and the relevant sections of the *OHS BoK* chapters 17.2 Health Effects of Hazardous Chemicals, 17.3 Dusts, Fumes and Fibres, and 17.4 Process Hazards (Chemical).

[31] See *OHS BoK* 17.3 Dusts, Fumes and Fibres.

7.2 Evaluation of effectiveness of control

Once implemented, the effectiveness of the controls should be evaluated on an ongoing basis. Information on the effectiveness of controls may be collected in several ways:

- Routine ambient air monitoring to determine whether air concentrations are maintained below the recommended exposure limits
- Engineer control data, e.g. compliance with checking schedule, how well is extraction system / dust suppression system working, etc
- Walk-through surveys to observe correct handling of materials and the appropriate use of engineering, administrative and PPE controls
- Reporting and investigation of spills, losses of containment, environmental releases, and health surveillance or exposure and/or biological monitoring standards being exceeded
- Communication with workers, supervisors and managers about chemical hazards, potential and actual exposures, and the need for monitoring.
- It is worth noting that the extent of control should match the extent of risk. To under-control is unethical; to over-control may cost the opportunity of useful preventive action elsewhere.

7.3 Mitigation of impacts of hazardous chemicals

When there has been a chemical exposure event, actions that mitigate the impacts will be required. These actions will vary depending on whether the event was related to the reactivity of the chemicals and/or health effects of the chemicals.

7.3.1 Mitigation of reactive chemical impacts

Events involving reactive chemicals typically involve a loss of containment; such a loss is usually preceded by a loss of control of the process. Mitigation strategies should be focused on preventing, detecting and responding to any loss of control to enable intervention early in the causation timeline.[32] Focusing on loss of control can be the key to prevention of incidents and minimisation of consequences.

[32] See *OHS Bok* 17.4 Process Hazards (Chemical).

A two-stage approach is applied to mitigation of impacts of reactive chemicals:

- Minimisation of the consequences, which is usually achieved with a range of active-engineered barriers (e.g. detection systems and fire suppression systems) and administrative barriers (e.g. evacuation).[33]
- Post-event emergency response based on well-developed and practiced emergency plans.[34]

Planning for post-event emergency response can be informed by information in the SDSs for chemicals held on site. SDSs are required to include information on:

> (d) Section 4: First aid measures;
> (e) Section 5: Firefighting measures;
> (f) Section 6: Accidental release measures; ...
> (l) Section 12: Ecological information … (WHSR, Schedule 7; SWA, 2022b)

7.3.2 Mitigation of health impacts

Mitigation of health impacts of chemical exposure should first focus on first aid treatment for any affected persons. If the chemical materials are known to cause chronic health effects, there may be additional actions needed to ensure the ongoing health of persons involved, including provision of medical care and/or ongoing health monitoring.[35] The workplace may require air and/or health monitoring (section 6.2.4) to collect information on the efficacy of controls and the need to review control measures. Some materials may require specialist first aid kits or treatment, e.g. hydrofluoric acid.

7.4 Communication

When making decisions about chemical management, it is very important to communicate regularly, although not necessarily frequently, with the people affected and/or those able to influence the management decisions. These people might include:

- Workers directly involved in the tasks being assessed and their representatives. They will need to provide information about the work as performed; they may be involved in collection of monitoring data. The results of any monitoring will need to be shared with these workers and summarised and shared with the whole work group.
- Supervisors will need to be consulted about processes and kept informed of results and any suggested changes to work processes.
- Management will need to be kept abreast of the need for task assessment and any request for resources. They will need to be informed if there are any adverse health

[33] See *OHS BoK* 13 Managing Process Safety.

[34] See *OHS BoK* 36 Emergency Management.

[35] See *OHS BoK* 35 Mitigation of Health Impacts.

monitoring data.

- OHS representatives may need to be informed as part of the formal consultation process.
- Engineers, maintenance, quality control personnel, etc, as needed if engineering controls need to be designed, installed and maintained.
- Chemical purchasers (in house) and suppliers may need to be informed if their product is causing workplace issues, especially if the risk assessment results in a change in purchasing practice
- Designers of processes and facilities.

Communications should be appropriate to the recipients; shop floor employees often prefer verbal information such as a tool box talk in a timely manner, while management may prefer briefings as a written email or formal reports. Requests for resources may require submission of specific forms. Some information will need to be formally presented to Safety Committees and/or recorded as Standard Operating Procedures.

8 Product stewardship

Importers, manufacturers and suppliers of hazardous chemicals have legal responsibilities under the model WHS Act requiring them to, as far as reasonably practicable:

- Ensure the chemical is designed, manufactured and supplied so as to be without risk to the health and safety of persons when used for the purpose for which it was designed
- Ensure that necessary calculations, analysis, testing or examination are carried out
- Provide current information on its purpose, results of analysis and testing and conditions necessary for its safe use. (ss 22-25; SWA, 2022a)

Also, producers and suppliers of chemical products are required to provide GHS-compliant labels and SDSs to their customers (SWA, 2023b). Suppliers are expected to provide information on environmental regulations and disposal instructions in the SDS. It is incumbent on suppliers, particularly importers, to ensure this information is accurate and complies with local regulations.

Increasingly, the concept of product stewardship is expanding beyond legal requirements, often in response to community demand.

> Product stewardship is an approach to managing the impacts of different products and materials on the environment and human health and safety. …. It accepts that those involved in designing, manufacturing, selling and disposing of products have a role to play. (Australian Government, 2022a,b)

Although most product stewardship schemes currently focus on products such as single-use plastics and mobile phones, there is some attention to chemicals through schemes to address plastic oil containers, paint (Paintback) and agricultural chemicals (drumMUSTER®) (Chaplin, 2018).

9 Implications for OHS practice

All decisions about chemical hazards and required controls are predicated on knowing the materials involved, how they are used in the workplace, how they may behave and how they cause damage if not managed correctly. Thus, the first step for the generalist OHS professional is to identify the chemicals from their labels and link them to the SDSs. Informed by a basic understanding of chemicals, chemical states and chemical reactions, as well as the label and SDS, the generalist OHS professional can determine the nature of the potential harm and how this might be caused.

A chemical register must be established if the chemicals are hazardous, with details including the chemical name, nature of the hazard (GHS, DG and/or HAZCHEM classifications), location and quantity for the particular workplace.

Where the chemical is hazardous and the controls are known, it may be appropriate to move directly to implement the recommended controls, ensuring that systems are in place to communicate the changes to workers and to monitor the effectiveness of the controls. Ensure that all phases (purchasing, storage, use and disposal) of material use are considered.

If control strategies are not immediately known, a risk assessment should be conducted. This may be a *qualitative risk assessment* based on inspection, observation and workplace consultation, or evidence may be gathered from investigation of incidents, first aid and medical reports, supported by some basic monitoring if the material has an exposure standard. Depending on the nature of the hazard (toxicity/severity) and the complexity of the situation, a *quantitative risk assessment* may be required. Such assessments should be conducted by an occupational hygienist conversant with the substances involved. This assessment will require monitoring data and knowledge of the work system, current controls, applicable PPE and its usage, training, etc.

In implementing controls, legislative compliance is the minimum acceptable outcome. The prudent organisation will go beyond regulatory compliance to ensure workers are adequately protected (e.g. some Australian mining companies will set an in-house 'action limit' whereby they react if their workers are exposed at 50% of the current exposure standard). The long latency of some human responses to chemical hazards and the ongoing development of our knowledge about the impact of some chemicals mean that legislative compliance may not provide adequate protection in the long term.

The hierarchy of controls as it applies to chemical hazards is well understood; however, this should be applied in a systematic and systemic manner as the complexity of some situations will require a range of controls acting as barriers and defenses.[36] Strategies should be put in place to monitor, record and maintain the effectiveness of controls.

In managing chemical hazards or investigating disease potentially caused by chemical exposure, the generalist OHS professional may need to liaise with one or more technical specialists to obtain greater understanding of the work environment and the necessary controls. The expertise of a range of specialists may be required, including:

- Certified occupational hygienist (COH®) with expertise in the relevant area for advice on exposure assessment and control
- Chemists with expertise in classification of hazardous materials and SDS preparation and labelling
- Dangerous goods consultant[37] for advice on transport to, and storage and handling of material on site
- Production engineer for safe work practices (e.g. machine guarding, machine loading devices)
- Chemical engineer for engineering controls (e.g. in the design phase of ventilation systems, considering the behaviour of airborne materials in moving air streams)
- Occupational physician for biological monitoring analysis and overall health monitoring
- Occupational health nurse, who may be the first to receive reports of health effects and may conduct a range of health monitoring assessments in-house prior to external input
- Epidemiologist to determine the strength of association between chemical exposure and disease
- Toxicologist to determine safe levels of exposure through health-based risk assessment.

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[36] See *OHS BoK* 34.1 Prevention and Intervention and *OHS Bok* 17.4 Process Hazards (Chemical).

[37] Membership of the Australian Institute of Dangerous Goods Consultants may be an indication of qualification in this speciality.

The OHS professional would be expected to orient the specialist to the site, clarify the nature and scope of the work, and facilitate clear communication with managers, supervisors and operators. The generalist OHS professional thus needs a well-rounded chemical management knowledge base that supports an initial observational approach supplemented with specialist input as required.

10 Management of hazardous chemicals in practice

Consider the following scenario[38]:

You have just taken a job as the OHS professional reporting to the Operations Manager at a particleboard manufacturing business. The company is very innovative and proud of its eco credentials. It has developed a new eco-friendly high density fiberboard construction product with very low free formaldehyde content, high elasticity and bending strength but low water absorption and thickness swelling, all attributes desired in the construction industry.

As you become familiar with your new job, you notice that there are several steps in the production process: mixing the wood fibre with wax and urea formaldehyde/lignosulfonate resin, forming panels, baking the panels then trimming panels.

Where do you start?

1. Acquire SDS for all materials and record their hazards; these may be in your chemical register:
   - Wood fibre
   - Wax
   - Urea formaldehyde resin
   - Lignosulfonate
   - Any substances produced in the production process (are there any?)

   If there is not a formal chemical register, establish one
2. Risk assessment
   - Approach by individual tasks in the process
   - Determine hazards associated with each task, e.g. chemical exposures, manual handling issues, noise, etc
   - Assess method(s) of potential exposure: discuss with workers and supervisors, and make observations about whether inhalation or skin contact occurs for each material at each phase of the task
   - Estimate potential exposure for each material at each step: e.g. lots, little, no clue. Consult with workers and supervisors about potential for exposure
3. Risk decision:
   - For those little exposures to low hazard materials, ensure that work process continues as

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[38] Antov, P; Savov, V; Kristak, L; Reh, R and Mantanis, G I (2021) Eco-Friendly, High-Density Fiberboards Bonded with Urea-Formaldehyde and Ammonium Lignosulfonate. https://www.mdpi.com/2073-4360/13/2/220#

assessed

- For exposures, e.g. skin contact and/or inhalation of hazardous materials, in consultation with workers and management, determine how to control immediately
- For some exposures to hazardous materials, request assistance from specialist(s), e.g. occupational hygienist. Review any data on known incidents, health events, any previous monitoring
- Don't forget to consider materials generated in the manufacturing process, e.g. is formaldehyde off-gassed in the baking process or wood dust in the trimming process?

4 Risk Communication

- Determine who needs to know about the decisions, e.g. workers, supervisors and managers directly affected, OHS representatives, customers, suppliers
- Communicate appropriately with each party
- Adjust any Operating Procedures to reflect new ways of working and adjust any maintenance requirements
- Record the risk decision in the site risk register

11 Summary

Chemical hazards are a major ongoing, but manageable, OHS issue in Australian workplaces. While workers in some industries and specific workplaces have a higher risk of exposure, all workplaces have some exposures to chemicals.

The Globally Harmonized System for Classification and Labelling of Chemicals (GHS) provides information to support a systematic approach to identification and assessment of chemical hazards. Sources of information for hazard identification include chemical labels, safety data sheets and appropriate hazardous chemical databases. Together with established exposure standards, these sources provide reference points against which workplace information can be compared.

Risk factors and processes are different for reactive chemicals and chemicals that produce adverse health effects. Risk assessment for reactive chemicals considers:

- The nature of the chemical reactivity of the substance
- Environmental factors
- Operating factors
- Potential consequences.

Risk assessment for known or possible toxic chemicals is based on:

- Physical/chemical state of the material

- Toxicity and dose-response relationship
- Route of exposure
- Extent of exposure
- Nature of the task or activity involving the chemical
- Workplace environment
- Individual worker.

The hierarchy of control measures provides a useful guide to the development of controls and, as with other hazards, there should be a 'package' of controls to create barriers and defenses. Programmed, effective and ongoing monitoring of controls at all levels of the hierarchy is required to ensure the reliability of these barriers and defenses. These controls should be supplemented with strategies to mitigate the impact of any loss of control. For reactive chemicals, mitigation strategies include engineered and administrative barriers and emergency response to minimise escalation. Mitigation of health effects of toxic chemicals involves early notification, first aid and medical treatment, and air and health monitoring.

The generalist OHS professional has a vital role in managing hazardous chemicals in the workplace. Although they may need to liaise with one or more technical specialists, this chapter and companion chapters – *OHS BoK* 17.2 Health Effects of Hazardous Chemicals, 17.3 Dusts, Fumes and Fibres, and 17.4 Process Hazards (Chemical) – provide the knowledge base to fulfill their generalist role in managing chemical hazards.

References

Antov, P; Savov, V; Kristak, L; Reh, R and Mantanis, G I (2021) Eco-Friendly, High-Density Fiberboards Bonded with Urea-Formaldehyde and Ammonium Lignosulfonate. https://www.mdpi.com/2073-4360/13/2/220# accessed 14/4/23

Australian Government. (2022a). *Product stewardship schemes and priorities*. Department of Climate Change, Energy, the Environment and Water. https://www.dcceew.gov.au/environment/protection/waste/product-stewardship/products-schemes

Australian Government. (2022b). *Minister's priority list*. Department of Climate Change, Energy, the Environment and Water. https://www.dcceew.gov.au/environment/protection/waste/product-stewardship/ministers-priority-list

CCOHS (Canadian Centre for Occupational Health and Safety). (2004). *Synergism and related terms*. http://www.ccohs.ca/oshanswers/chemicals/synergism.html

Chaplin, L. (2018). *Summary of product stewardship case studies* (Industry Working Group Report). https://bsc.org.au/wp-content/uploads/2019/05/05.-Summary-of-Product-Stewardship-Case-Studies-180308.pdf

Eaton, D. L., & Gilbert, S. G. (2015). Principles of toxicology. In C. D. Klaassen & J. B. Watkins, *Casarett & Doull's essentials of toxicology* (3rd ed). McGraw-Hill.

ILO (International Labour Organization). (2021). *Exposure to hazardous chemicals at work and resulting health impacts: A global review.* https://www.ilo.org/global/topics/safety-and-health-at-work/resources-library/publications/WCMS_811455/lang--en/index.htm

Manno, M., Viau, C., Cocker, J., Colosio, C., Lowry, L., Mutti, A., Nordberg, M., & Wang, S. (2010). Biomonitoring for occupational health risk assessment (BOHRA). *Toxicology Letters*, *192*(1), 3-16. https://doi.org/10.1016/j.toxlet.2009.05.001

NTC (National Transport Commission). (2020). *Australian code for the transport of dangerous goods by road & rail* (Edition 7.7). Commonwealth of Australia. https://www.ntc.gov.au/sites/default/files/assets/files/ADG%20Code%207.7_0.pdf

OSHA (Occupational Safety and Health Administration). (2016). *Hazard communication: Hazard communication guidance for manufacturers, importers, and employers* (OSHA 3844-02 2016). https://www.osha.gov/sites/default/files/publications/OSHA3844.pdf

SWA (Safe Work Australia) (n.d.). *Using the GHS*. https://www.safeworkaustralia.gov.au/safety-topic/hazards/chemicals/classifying-chemicals/using-ghs

SWA (Safe Work Australia). (2018). *How to manage work health and safety risks: Code of practice*. https://www.safeworkaustralia.gov.au/doc/model-codes-practice/model-code-practice-how-manage-work-health-and-safety-risks

SWA (Safe Work Australia). (2019). *Hazardous chemical register template*. https://www.safeworkaustralia.gov.au/safety-topic/hazards/chemicals/hazardous-chemical-records-and-signs-workplaces/hazardous-chemicals-register

SWA (Safe Work Australia). (2020a). *Classifying hazardous chemicals: National guide.* https://www.safeworkaustralia.gov.au/doc/classifying-hazardous-chemicals-national-guide

SWA (Safe Work Australia). (2020b). *Health monitoring: Guide for persons conducting a business or undertaking.* https://www.safeworkaustralia.gov.au/doc/health-monitoring-persons-conducting-business-or-undertaking-guide

SWA (Safe Work Australia). (2020c). *Labelling of workplace hazardous chemicals: Code of practice*. https://www.safeworkaustralia.gov.au/doc/model-codes-practice/model-code-practice-labelling-workplace-hazardous-chemicals

SWA (Safe Work Australia). (2020d). *Managing risks of hazardous chemicals in the workplace: Code of practice*. https://www.safeworkaustralia.gov.au/doc/model-code-practice-managing-risks-hazardous-chemicals-workplace

SWA (Safe Work Australia). (2020e). *Preparation of safety data sheets for hazardous chemicals: Code of practice.* https://www.safeworkaustralia.gov.au/doc/model-codes-practice/model-code-practice-preparation-safety-data-sheets-hazardous-chemicals

SWA (Safe Work Australia). (2021a). *Hazardous chemical information system (HCIS).* http://hcis.safeworkaustralia.gov.au/

SWA (Safe Work Australia). (2021b). *Managing the risks of respirable crystalline silica from engineered stone in the workplace: Code of practice*. https://www.safeworkaustralia.gov.au/doc/model-code-practice-managing-risks-respirable-crystalline-silica-engineered-stone-workplace

SWA (Safe Work Australia). (2022a). Model Work Health and Safety Bill. Parliamentary Counsel's Committee. https://www.safeworkaustralia.gov.au/doc/model-work-health-and-safety-act

SWA (Safe Work Australia). (2022b). *Model work health and safety regulations*. Parliamentary Counsel's Committee. https://www.safeworkaustralia.gov.au/sites/default/files/2022-06/model_whs_regulations_-_14_april_2022.pdf

SWA (Safe Work Australia). (2023a). Chemicals. Retrieved from Safeworkaustralia.gov.au/safety-topic/hazards/chemicals.

SWA (Safe Work Australia). (2023b). *Transition to GHS 7*. https://www.safeworkaustralia.gov.au/safety-topic/hazards/chemicals/classifying-chemicals/transition-ghs72

Taylor, A. (2014, December 2). Bhopal: The world's worst industrial disaster, 30 years later. *The Atlantic*. https://www.theatlantic.com/photo/2014/12/bhopal-the-worlds-worst-industrial-disaster-30-years-later/100864/

TGA (Therapeutic Goods Administration). (2022). *The poisons standard (the SUSMP).* Australian Government. https://www.tga.gov.au/publication/poisons-standard-susmp

UNECE (United Nations Economic Commission for Europe). (2021a). *About the GHS.* https://unece.org/about-ghs

UNECE (United Nations Economic Commission for Europe). (2017). *Globally harmonized system of classification and labelling of chemicals (GHS Rev. 7, 2017).* https://unece.org/ghs-rev7-2017