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WorkSafe VICTORIA

Compliance code

Foundries

State Government Victoria

Contents

WorkSafe Victoria is a trading name of the Victorian WorkCover Authority.

Preface

This compliance code provides practical guidance to those who have duties under the *Occupational Health and Safety Act 2004* (the OHS Act) or Occupational Health and Safety Regulations 2007 (the Regulations). It shows how to comply with those duties or obligations.

It was made under the OHS Act and was approved by The Hon. Tim Holding MP, Minister for Finance, WorkCover and the Transport Accident Commission, on 19 September 2008.

This compliance code has been developed by WorkSafe Victoria. Representatives of employers, employees and government agencies were consulted during its preparation.

Employers, employees, self-employed persons and those with management and control of workplaces need to use the compliance code in conjunction with the Act and Regulations.

This compliance code is not mandatory. A relevant duty holder who complies with the compliance code will – to the extent the compliance code deals with their duties or obligations under the OHS Act and Regulations – be considered to have complied with their duties and obligations.

If conditions at the workplace or the way work is done raise different or additional risks not covered by the compliance code, compliance needs to be achieved by another means.

WorkSafe publishes guidance to assist with this process at **worksafe.vic.gov.au**.

Evidence of a failure to observe a compliance code may be used as evidence in proceedings for an offence under the OHS Act or Regulations. However, a duty holder will not fail to meet their duty or obligation simply because of a failure to observe a compliance code.

A WorkSafe inspector may cite a compliance code in a direction or condition in an improvement notice or a prohibition notice as a means of achieving compliance.

A health and safety representative (HSR) may cite a compliance code in a provisional improvement notice when providing directions as to how to remedy an alleged contravention of the OHS Act or Regulations.

The approval of a compliance code may be varied or revoked by the Minister. To confirm that this compliance code is current and in force, go to **worksafe.vic.gov.au**.

Please note: On 18 June 2017, the Occupational Health and Safety Regulations 2017 (OHS Regulations 2017) replaced the Occupational Health and Safety Regulations 2007, which expired on this date. This compliance code has not yet been updated to reflect the changes introduced by the OHS Regulations 2017. Complying with a compliance code made in relation to the old regulations may not necessarily mean compliance with a duty under the new regulations. Information on the key changes introduced by the OHS Regulations 2017 can be found in the guidance titled *Occupational Health and Safety Regulations 2017: Summary of changes* available at worksafe.vic.gov.au

Introduction

Purpose

1. The purpose of this compliance code is to provide practical guidance on how employers who undertake foundry work can meet their duties under the *Occupational Health and Safety Act 2004* (the OHS Act) and Occupational Health and Safety Regulations 2007 (the Regulations).

Scope

2. This code covers foundry work that predominantly involves the casting of molten metal into a mould. It can be done manually (static casting) or automatically (injection, die or continuous casting). A typical process includes preparing a mould casting, melting and pouring metal into the mould, and removing and finishing the casting.

3. Because of the diverse and hazardous nature of the work environment, foundries present a range of risks, including:

   - explosion and burns from molten metal
   - respiratory disorders from exposure to gases, vapours, fumes and dusts
   - effects on skin from contact with corrosive chemicals
   - eye injuries from light radiation, metal fragments or chemical splashes
   - heat stress, heat stroke and fatigue from hot working conditions
   - slips, trips and falls
   - joint and muscle sprains and strains
   - mechanical hazards from machinery and equipment (such as entanglement or crushing)
   - non-mechanical hazards from machinery and equipment (such as vibration and noise).

4. The code provides practical guidance on foundry specific hazards but also refers to other hazards related to foundry work. Risk controls set out in the boxes throughout the code are considered to be one means of meeting a duty holder's obligations so far as is reasonably practicable. If the risk controls are not appropriate to the particular circumstances in a foundry, a duty holder is expected to implement equally effective controls by applying the approach shown in paragraphs 13–16. Where hazards are subject to specific regulation (eg hazardous substances), the specific regulation should be relied on for compliance to be achieved.

Introduction

Application

5. This compliance code is primarily aimed at employers, managers and the self-employed in foundries. It may also be of assistance to employees, health and safety representatives (HSRs) and consultants who work in the foundry industry.

Duties

Duties of employers

6. Section 21 of the OHS Act states that employers must, so far as is reasonably practicable, provide and maintain a working environment for their employees (including independent contractors and their employees) that is safe and without risks to health.

7. This means employers must eliminate any risks to health and safety, so far as is reasonably practicable. If it is not reasonably practicable to eliminate the risks, employers must reduce them so far as is reasonably practicable.

8. Further, employers must, so far as is reasonably practicable, monitor workplace conditions and employees' health, and provide employees with information on health and safety at the workplace. This should include the names of people they can discuss their health and safety concerns with. Employers must also keep records relating to employees' health and safety, and engage qualified people to provide health and safety advice, so far as is reasonably practicable (section 22).

9. In addition, the Regulations specify that employers must:

    - ensure that control measures are properly installed, used and maintained (regulation 2.1.1)
    - give employees sufficient information, instruction and training about workplace hazards and the need for proper use of and maintenance of control measures (regulation 2.1.2)
    - provide information about the purpose and nature of health surveillance, pay for health surveillance (regulation 2.1.3), and ensure that the employee and any third party the employee authorises receives a copy of the results of the health surveillance, and that the employer's copy remains confidential (regulation 2.1.4).

10. Employers must also comply with additional duties prescribed in the Regulations in relation to specific hazards such as hazardous substances, lead, manual handling, plant noise and falls.

11. Employers need to give employees the information, instruction and training they need to work safely and without risks to health, before they start work in a foundry. Once work starts, employees need to be supervised. In particular:

    - employees must not work on any task until they have been given safety and operational training and have been advised of emergency procedures
    - employers must instruct employees in safety procedures, the reasons for the procedures and the potential hazards of each task, in a language the employee understands. If there are employees who speak English as a second language, employers need to refer to WorkSafe's *Communicating occupational health and safety across languages* compliance code
    - employers must supply personal protective equipment (PPE) and instruct employees on its proper fit, use and maintenance

- employers must instruct employees in fire-fighting procedures, the use of fire-fighting equipment, and what to do in the event of a molten metal spill
- employers must instruct employees in safe machine operation, guarding requirements and control measures
- employees need to be encouraged to report any unsafe procedures, equipment or work areas to their supervisor or manager
- employees need to be supervised, but if the nature of the work requires an employee to work in isolation, then all risks must be identified and controlled, so far as is reasonably practicable.

Duties of employees

12. Section 25 of the OHS Act places a duty on employees to take reasonable care for their own health and safety and the health and safety of others who may be affected by their work, and to cooperate with their employer's efforts to make the workplace safe.

Controlling OHS hazards and risks

13. Good health and safety practice requires the elimination and control of hazards and risks. This is best achieved by a proper consideration of the sources of harm and what can be done to prevent the harm from occurring.

14. The control of OHS hazards and risks can be undertaken by a four-step process:

    - Step 1 – Identify hazards: know what hazards are present.

      Identifying hazards involves finding all of the foreseeable hazards in the workplace and understanding the possible harm that the hazards may cause.
    - Step 2 – Assess risks: understand the nature of risks, the harm that could occur and the likelihood.

      Risk assessment is a process for developing knowledge and understanding about hazards and risks so that sound decisions can be made about control. A formal risk assessment is unnecessary if the knowledge and understanding already exist. However, there will be many times when a risk assessment is the best way of building knowledge and understanding.
    - Step 3 – Control hazards and risks: determine options for eliminating or reducing risk, select the best and implement it.

      Duty holders are required to ensure health and safety by controlling risks. Risks must be controlled by eliminating them so far as is reasonably practicable or, if this is not possible, reducing the risks that remain so far as is reasonably practicable.
    - Step 4 – Check controls: review the implemented controls to ensure they are effective.

      Controls that are put in place to protect health and safety need to be monitored to ensure that they work as planned. This requires checking them and ensuring that processes are put in place to identify and quickly fix problems. Checking controls involves the same methods as in the initial hazard identification (Step 1), and creates the loop by which workplace health and safety measures are maintained. Control measures must be maintained to ensure that they working effectively.

15. For more detailed guidance, refer to WorkSafe's *Controlling OHS hazards and risks – A handbook for workplaces.*

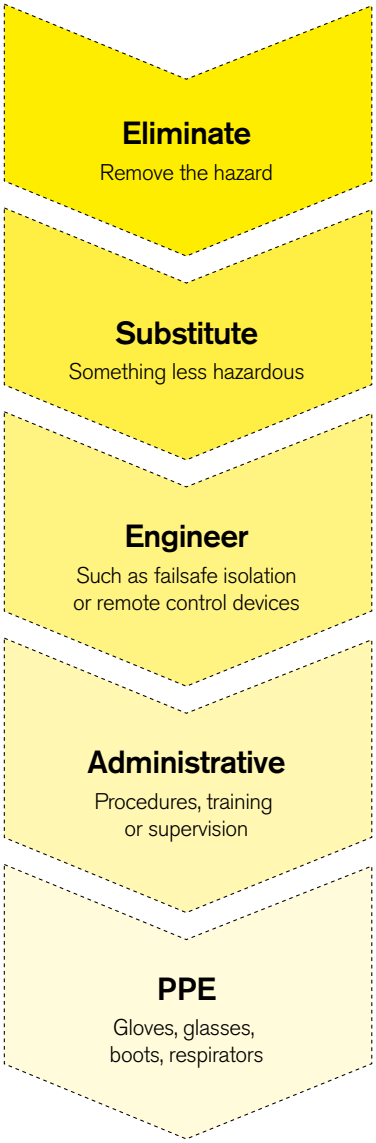


Figure 1: Hierarchy of control.

Hierarchy of control

16. Employers must, so far as is reasonably practicable, identify tasks undertaken by employees that present risks to health and safety. This must be done in consultation with employees and their HSRs. Employers must then eliminate or reduce those risks so far as is reasonably practicable.

    Guidance on what reasonably practicable means can be found in the WorkSafe Position *How WorkSafe applies the law in relation to reasonably practicable*.

    The Regulations prescribe that control measures be applied in a certain order (or hierarchy) for workplace hazards such as:

    - asbestos
    - confined spaces
    - falls
    - hazardous substances
    - lead
    - manual handling
    - noise
    - plant.

    Refer to the Regulations for the prescribed hierarchy of controls for each of these hazards.

    The hierarchy of controls is the preferred and required order of control measures for managing risks in foundries.

    When deciding on the best way to control a risk, employers must start at the top of the hierarchy of controls. First, investigate if the risk can be eliminated (eg by removing the hazard). If this is not reasonably practicable, then reduce the risk through substitution (eg by using safer substances or equipment). If these methods are not reasonably practicable, use engineering or administrative controls to reduce the risk. Personal protective equipment (PPE) is the last option and the last line of defence. A combination of measures may be needed to adequately control the risk.

    For more information about identifying hazards and controlling risks, refer to the WorkSafe Position *How WorkSafe applies the law in relation to identifying and understanding hazards and risks*.

Consultation

17. By law, so far as is reasonably practicable, employers must consult with HSRs and employees on a range of matters that directly affect (or are likely to directly affect) their health and safety. In relation to OHS in foundries, examples of consultation would include:

    - consultation during the hazard identification process
    - consultation on the selection of suitable risk controls to reduce risk in foundries
    - consultation on any proposed changes to safe work procedures in foundries.

18. For more information on the consultation provisions, see Appendix C and WorkSafe's *Consultation on health and safety – A handbook for workplaces*.

Foundry hazards and controls

Molten metal explosions

Steam explosions

19. Steam explosions are caused by the introduction of moisture into molten metal. Sources of moisture include:
    - containers that hold liquids (such as drink cans, aerosols or mobile phone batteries)
    - heavily oxidised or rusted materials, or rust on the surface of tools or equipment
    - damp refractories or tools.

To control the risks, employers need to ensure that:

- potential sources of moisture that could come into contact with molten metal are identified, and steps are taken to prevent this. Ensure materials are free of moisture on receipt and store in an appropriate dry location
- furnaces and refractories are preheated before use
- all equipment and tools are free of rust and are preheated before use (see page 25)
- charges are dry and free from any entrapped moisture before being added to molten metal (see page 27)
- bottles and containers that hold liquid and sealed or pressurised cans are prohibited (or if such items are required for maintenance or operational use, their storage, use and disposal are strictly controlled by the employer).

Chemical explosions

20. Chemical explosions occur through the introduction of reactive chemical substances to molten metal directly or as a contaminant in charge material.

To control the risks, employers need to ensure that:

- personal butane cigarette lighters are banned in all molten metal areas
- paints, solvents and other combustible or flammable materials are stored in designated areas to avoid ignition and cross-contamination
- storage systems are in place to ensure products not suitable for use with molten metal are clearly labelled, secured against accidental use and stored outside molten metal areas
- the last step before adding anything to molten metal is confirming that it is the correct product and is safe for use in that particular melt.

Heat stress

21. Working in hot conditions is hazardous. Health effects range from discomfort or heat rash to heat exhaustion or heat stroke resulting in permanent damage or death. Heat stress can harm without the worker being aware of the degree of effect until it is almost too late. It affects concentration, perception and decision making, so heat stress is also dangerous in less obvious ways. The risks of harm are controllable by a practical program, such as the one outlined on page 8.
22. Other factors besides furnace heat contribute to heat problems. Job factors include strenuous and/or sustained work and inadequate recovery time. Seasonal factors include high air temperature and relative humidity or low air movement. Excessive or inappropriate clothing or PPE and fatigue are also factors.

23. Over time, employees who work in hot environments acclimatise or adapt to the heat. This reduces discomfort, increases sweating effectiveness, reduces salt loss and returns recovery rate to normal. Acclimatisation takes time and is lost when employees are away from the environment – for example, if employees go on vacation. Employees who have been away for a week or more need to be given time to reacclimatise. Acclimatisation only provides partial protection. While acclimatised workers are at less risk than unacclimatised, they are still at risk.

To control the risks, employers need to ensure that:

- unnecessary heat and water vapour sources are eliminated
- radiant emissions from plant and other hot surfaces are shielded
- spot coolers, blowers, fans or airconditioning relieve humidity and move the air
- de-humidifiers and other humidity reduction methods are used
- ventilation such as flues draw cooler air in
- tasks are automated where reasonably practicable
- clean fresh water is supplied
- employees have access to a respite area such as a cool room or heat refuge
- a policy and associated procedures on heat stress are developed and employees are fully trained in the requirements. The policy needs to include:
  - an acclimatisation process
  - a 'buddy system' where each looks after the other
  - provision for frequent short water breaks at regular intervals during the shift, (eg a cup of water (250ml) every 15–20 minutes)
  - pacing of work to suit the conditions
  - scheduling of hot work in cooler parts of the day or isolating it by distance from other workers
  - rotation of hot tasks between employees to minimise exposure time
  - employees are trained, educated and continuously monitored for signs (symptoms) of excessive heat exposure and heat stroke
  - contingency and treatment for affected employees
- in addition to other control measures, task-specific PPE (eg water cooled or heat reflective clothing is provided) (see page 35).

Burns

24. Burns are one of the major types of injuries in molten metal foundries and are generally caused by contact with hot surfaces, radiation or molten metal splashing.

To control the risks, employers need to ensure that:

- employees not directly involved in casting operations are separated from the casting area
- automated machinery is used so far as is reasonably practicable, to reduce risks associated with manual handling of casting moulds and other equipment
- suitable protective barriers such as screens around the pouring station are provided to protect against the heat and splash when adequate safe distance cannot be provided
- in addition to other control measures, task-specific PPE is provided (see page 35)
- only dry PPE is used when working with molten or hot metal.

Light radiation

25. Eye disorders and skin burns may be caused by intense ultraviolet and infrared radiation from molten metal in furnaces, particularly around pouring areas and in welding operations. Bystanders and passersby also need to be protected, preferably by exclusion.

To control the risks, employers need to ensure that:

- shielding and PPE, such as filtered eye protection, are provided for all employees who are likely to be exposed
- all employees are advised of the risks associated with intense ultraviolet and infrared radiation.

Hazardous substances

26. Hazardous substances such as lead, amines, formaldehyde, toluene, phenol, furfuryl alcohol and isocyanates are substances that can harm the health of people exposed to them. They can be inhaled, swallowed or absorbed through the skin, and employees can suffer immediate or long-term health effects. Exposure may cause irritation, chemical burns, cancer, birth defects or diseases of certain organs such as the lungs, liver, kidneys and nervous system.
27. In addition, many airborne contaminants (eg gases, vapours, dusts and fumes) that are hazardous substances can be produced from foundry processes.

28. Gases such as acrolein, ammonia, carbon dioxide, chlorine, formaldehyde, hydrogen chloride and sulphide, methane and nitrogen are often stored as liquids under pressure. In the foundry, gases (eg sulphur dioxide, ozone, carbon monoxide) are often by-products of foundry processes. Some gases such as carbon monoxide have no give-away odours and may not be detected until their irritating effects such as respiratory difficulty, coughing, asthma and eye watering are detected.
29. Vapours such as benzene, dimethylamine, isocyanates, formaldehyde and naphthalene are the gaseous form of substances that are liquid or solid at room temperature. They come from solvents, paints, binders or catalysts that evaporate during heating or spraying.
30. Dusts are generated from solids and are dispersed by movements during cleaning, loading or handling materials. Dusts have serious health implications. For example, wood dust causes alterations to the lining of the nasal cavity, skin rashes, inflammation, asthma and possibly cancer. Metal dusts cause siderosis, tracheobronchitis, pneumonitis, beryllosis, systemic poisoning and nervous system damage. Also see pages 13 and 33.
31. Fumes are formed when volatised solids (such as molten metals during charging and cleaning casts) condense in air. Fumes are also produced from the binding agents, resins and catalysts used in sand moulds and cores and during the melting and casting processes. Metal fumes can cause cancer and respiratory disorders.
32. Uncontrolled charging and melting processes can cause the excessive release of metal fumes or gases such as carbon monoxide, lead, zinc and other metal oxides. Accurate furnace temperature control is crucial in preventing excessive melt fuming.
33. Metal fume fever, an acute allergic condition, results from exposure to beryllium, lithium, zinc, copper, aluminium, antimony, iron, nickel or magnesium. Symptoms are flu-like: nausea, headache, fever, dry throat, coughing and muscular pains and start to appear four to 12 hours after exposure followed by chills and sweats. Attacks last six to 24 hours, usually subsiding 24 to 48 hours after removal from exposure.
34. Foundries should consult with Environment Protection Authority (EPA) Victoria on the release of contaminants into the atmosphere (eg air, land, noise, water).
35. In addition to the industry-specific controls shown on page 11, duty holders must also comply with chapter four (Hazardous Substances and Materials) of the Regulations and be able to demonstrate the implementation of controls to at least a standard detailed within the ‘state of knowledge’ relevant to these hazards.

To control the risks, employers need to ensure that:

- the use of hazardous substances is eliminated wherever possible
- hazardous substances are substituted with non-hazardous substances or substances that are less hazardous – for example, shot blasting of small castings instead of sand blasting (note that sand blasting is a prohibited activity)
- workers are isolated from areas where hazardous substances are produced (eg controlling a process from a filtered air control room), and dust filtering or settling devices from which air may escape are separated from the workplace (eg outside or in an enclosure vented to the open air)
- engineering controls are used to control exposure (eg canopy hoods near furnaces and extractor hoods above furnaces capture fumes and route them through an emission control system); fully enclosed extraction systems draw airborne contaminants away from employees rather than through their breathing zone; melting operations use automatic thermocouple control systems to manage the melting process; down-draught tables and grilles are large enough to allow cleaning to be conducted within the boundaries of the down-draught
- administrative controls are put in place to help prevent or reduce exposure (eg restricting employee access to process areas); preventing eating, drinking and smoking in work areas; a 'clean as you go' policy is introduced and cleaning methods involve wet and vacuum systems
- ventilation systems are regularly examined to ensure they are safe and functioning correctly and defects are repaired immediately
- task-specific protective equipment and clothing is worn by employees in the foundry (see page 35)
- Monitoring is in place to ensure exposure standards are not exceeded (see Appendix D).

In addition you are required to ensure:

- all substances are included in a hazardous substances register that includes their names and material safety data sheets (MSDS)
- all substances (including wastes) are stored in labelled containers
- health surveillance and biological monitoring is conducted where required
- records of monitoring are kept for 30 years.

Lead

36. Lead is a poison that accumulates in the body. It enters the body by ingestion and inhalation. Symptoms of lead exposure include headaches, tiredness, irritability, constipation, nausea, stomach pains and anaemia. In excess it leads to kidney, nerve and brain damage.

37. The Regulations require that employers provide job applicants and employees with information about the risks and toxic effects of lead exposure and the need for and details of biological monitoring and medical tests. Further, employers must eliminate the risk so far as is reasonably practicable to ensure that employees do not exceed exposure standards and conduct atmospheric and biological monitoring where required.

38. In addition to the industry-specific controls shown below, duty holders must also comply with Part 4.4 (Lead) of the Regulations, and the compliance code for lead. Duty holders must also be able to demonstrate the implementation of controls to at least a standard detailed within the 'state of knowledge' relevant to these hazards.

To control the risks, employers need to ensure that:

- workers are isolated from areas where lead fumes are being produced
- engineering controls are used to control exposure (eg extractor hoods above furnaces, dust extraction systems for buffing discing, grinding or cutting of castings containing lead); lead melting operations use automatic thermocouple control systems to manage the melting process
- administrative controls are put in place to help prevent or reduce exposure (eg rotating employees through a lead process to reduce exposure time); restricting employee access to process areas; preventing dry sweeping; work practices and equipment produce a minimum of residue
- task specific protective clothing and equipment is worn by employees in the foundry (see Personal protective equipment in the foundry – page 35)
- processes involving lead are confined to designated areas and sign posted
- lead process areas are kept clean and that cleaning does not increase the risk for others or spread contamination
- eating, drinking and smoking are prohibited in lead areas
- provision of changing and washing areas and the laundry/disposal of lead contaminated clothing
- exposure standards are not exceeded (see Appendix D).

In addition, you are required to ensure that:

- medical examinations and biological monitoring (eg regular blood lead testing) is conducted under the supervision of a registered medical practitioner
- records of monitoring are kept for 30 years.

Silica

39. Respirable crystalline silica is an occupational carcinogen. It causes silicosis (scarring of the lungs), a chronic disease that takes some time to develop. Its symptoms are shortness of breath, coughing and chest pain. These effects are not reversible, and in the long term fatal.

40. Silica dust is generated by a variety of processes such as mould and core making, cast cleaning, abrasive blasting, furnace maintenance, sand preparation and reclamation.

41. It is important that control measures are in place to ensure that the occupational exposure limit of 0.1mg/m^3 time weighted average (TWA) is not exceeded. Sand and other materials containing more than one per cent crystalline silica must not be used for abrasive blasting. This is a prohibited activity under the Regulations.

42. In addition to the industry-specific controls shown below, duty holders must also comply with Part 4.1 (Hazardous Substances) of the Regulations and be able to demonstrate the implementation of controls to at least a standard detailed within the 'state of knowledge' relevant to these hazards.

To control the risks, employers need to ensure that:

- there is a preferred use of non-silica products such as chromite or olivine sand
- wet or vacuum methods or other methods such as the addition of binders or sand delivery processes that reduce the amount of loose sand and effectively control potential generation of airborne particulate
- mechanical handling or preparation likely to generate occupationally significant concentrations of airborne dust and/or sand containing less than two per cent moisture or an alternative binding agent is not used unless extractive exhaust ventilation is used to collect and ventilate dust away from people
- enclosures or chambers, side draught or down-draught exhaust ventilation is introduced to control airborne contaminants from most foundry processes
- ventilation is positioned to draw dust away from employees rather than through their breathing zone
- down-draught tables and grilles are large enough to allow cleaning to be conducted within the boundaries of the down-draught
- dust filtering or settling devices from which air may escape are separated from the workplace (outside or in an enclosure vented to the open air)
- ventilation systems are regularly examined to ensure they are safe and functioning correctly
- defective and/or unsafe ventilation systems are repaired immediately
- air monitoring is introduced to ensure that the exposure standard is not exceeded
- a 'clean as you go' policy is introduced
- task-specific protective clothing and equipment is worn by employees in the foundry (see page 35).

Hazardous wastes

43. Legislative controls exist for the safe transport, storage and disposal of hazardous waste. Where no legislative controls apply, a safe means of transport and disposal (having regard to the nature of the hazard) needs to be employed (eg sealed, marked containers suitably protected from possible damage and able to be handled safely).

To control the risks, employers need to ensure that:

- hazardous waste is clearly identified and sealed in suitable containers
- containers are secured against damage
- task-specific protective clothing is worn by employees in the foundry (see page 35).

Dangerous goods

44. Dangerous goods such as carbon dioxide, formaldehyde, oxygen, sulphur dioxide and xylene are hazardous for a variety of reasons – they may be highly flammable, explosive, corrosive, acutely toxic, asphyxiant or highly reactive according to class. They are readily identifiable by class diamonds on the labels.

45. One of the biggest hazards in foundries is the potential for dangerous goods to be incorrectly marked, mixed with common foundry salts and additives, and placed into open crucibles or smelters containing molten metal. Major fires and explosions have occurred at foundries causing deaths and substantial property damage. These incidents have involved the accidental mixing of class 5.1 oxidizers such as ammonium or potassium nitrate or other oxidising salts into smelters or crucibles containing molten metal or aluminium.

46. In addition to the industry-specific controls shown below, duty holders must also comply with the regulations contained within the *Dangerous Goods Act 1985* and the Dangerous Goods (Storage and Handling) Regulations 2000 and be able to demonstrate the implementation of controls to at least a standard detailed within the 'state of knowledge' relevant to these hazards. For more information, see Appendix D.

To control the risks, employers need to ensure that:

- dangerous goods are labelled correctly
- use of dangerous goods is minimised
- a dangerous goods register containing details of all dangerous goods stored and handled in the workplace is established and maintained. The register should include material safety data sheets (MSDS) for each dangerous good. The register must be accessible to all employees
- MSDS are reviewed for properties, effects, precautions, appearance and safe handling techniques
- employees who use dangerous goods are educated, trained and supervised
- ignition sources are controlled
- incompatible chemicals are stored well apart and well away from smelter process areas
- dangerous goods are stored away from homes, meeting places such as shops, schools and public buildings, other workplaces and property boundaries
- placards are located on or near bulk stores of dangerous goods and storage and handling areas where required.

Slips, trips and falls

47. Slips, trips and falls are a common hazard in most workplaces, with consequences ranging from mild (such as scrapes) to severe (such as fractures or fatalities).

48. In addition to the industry-specific controls shown below, duty holders must also comply with Part 3.3 (Prevention of Falls) of the Regulations and be able to demonstrate the implementation of controls to at least a standard detailed within the 'state of knowledge' relevant to these hazards.

To control the risks, employers need to ensure that:

- trip hazards such as hoses, cords and rubbish are eliminated
- foundry layout is designed around workflow
- floors are level, firm and durable and do not accumulate water
- floor surface material resists damage from the foundry process. In areas where molten metal may spill, sand or refractory surfaces that resist very high temperatures are used
- regular housekeeping procedures ensure that sand or other process by-products do not build up
- PPE fits well so that tripping is not likely
- Task-specific protective clothing is worn by employees in the foundry (see page 35).

Manual handling

49. Manual handling tasks are those where force is exerted by a person to lift, lower, push, pull, carry or otherwise move, hold or restrain any object. These occur during pattern and core making, loading furnaces, moulding, fettling, dispatch, inspection and surface coating.

50. In addition to the industry-specific controls shown below, duty holders must also comply with Part 3.1 (Manual Handling) of the Regulations and be able to demonstrate the implementation of controls to at least a standard detailed within the 'state of knowledge' relevant to these hazards.

To control the risks, employers need to ensure that:

- hazardous manual handling tasks are eliminated whenever possible
- the work layout makes the task less hazardous (eg carrying items less distance or using conveyors)
- mechanical aids are used where possible (eg cranes or forklifts)
- tools, equipment and PPE are designed to minimise the risk of any manual handling task that is created or changed
- all staff are adequately trained, educated and supervised in manual handling safety.

Machinery and equipment (plant)

51. Machinery and equipment are used in pattern and core making as well as casting and moulding. Plant such as cranes, hoists, forklifts and conveyors are also used as mechanical handling devices within foundries.

52. There are three kinds of hazards associated with machinery and equipment:
    - mechanical hazards due to moving parts, ejected objects and equipment (such as forklifts) that may be operated in areas of pedestrian activity
    - non-mechanical hazards such as airborne contaminants, explosive atmospheres, heat, radiation, chemicals, vibration, electricity and noise
    - access hazards, including confined spaces, falls, and manual handling.

53. Employers need to carry out routine inspection and maintenance for all machinery and equipment to ensure it remains in a safe working condition. The adverse environmental conditions found in foundries (such as excessive vibration, machine lubricant contaminants, extreme heat and airborne contaminants) all increase stress on fittings and components, potentially exposing machinery and equipment to premature failure.

54. In addition to the industry-specific controls shown below, duty holders must also comply with Part 3.5 (Plant) of the Regulations and be able to demonstrate the implementation of controls to at least a standard detailed within the 'state of knowledge' relevant to these hazards.

Mechanical hazards

55. Mechanical hazards include hard surfaces coming together and scissoring action. Risks include entanglement, crushing, severing, cutting and slips, trips and falls.

To control the risks, employers need to ensure that:

- employees are separated from machinery and equipment by distance (eg enclosures), barriers (eg guards) or time (eg when machine is disabled)
- isolation procedures are followed prior to any maintenance or repair works
- automatic systems such as two-handed operation, presence sensors or fail-safe controls are in use
- machinery and equipment is regularly examined to ensure it is safe and functioning correctly and maintained to manufacturer's specifications
- maintenance, repair, installation, service and cleaning (MRISC) – activities are planned and safety supervision provided accordingly
- purchasing policy focuses on safety.

56. For more information about mechanical hazards refer to WorkSafe's *Machinery and equipment safety – An introduction*.

Non-mechanical hazards

Noise

57. Noise levels in excess of 85 decibels (dB(A)) averaged over eight hours, or a C weighted peak hold sound pressure reading of 140 dB(C) can result in hearing loss. Pattern and core making, moulding, knockout and cleaning operations, fettling and some furnaces are among the equipment and processes that produce noise levels in excess of the acceptable standard. Regular exposure to excessive noise can damage the inner ear and cause tinnitus leading to difficulties in communications.

dB(A) levels of common foundry equipment

Mould vibrators	L 85 – 114
Inverter	L 83 – 116
Arc/air gauging	L 82 – 107
9-inch angle grinder	L 97 – 110
Shot blasting	L 86 – 101
Shake out	L 84 – 95

58. In addition to the industry-specific controls shown below, duty holders must also comply with Part 3.2 (Noise) of the Regulations and be able to demonstrate the implementation of controls to at least a standard detailed within the 'state of knowledge' relevant to these hazards.

To control the risks, employers need to ensure that:

- current risk controls are checked to ensure that the noise exposure standard is not exceeded
- current plant is modified or replaced to reduce noise
- noisy tasks take place in soundproof enclosures or behind noise barriers
- quiet rest areas are provided
- task-specific hearing protection is worn by employees in the foundry (page 35).

59. Where hearing protection is required to be worn to control exposure to noise below the exposure standard, the employer is required to provide hearing tests (audiometric testing) every two years. The purpose of audiometric testing is to determine whether employees have suffered hearing loss due to exposure to noise. If that is the case, the employer needs to review their controls.

Vibration

60. Whole body (1–80 Hz) vibration takes place during shake out, sand-slinging, on forklifts, cranes and during pneumatic ramming operations. The adverse effects of whole body vibration include increased blood pressure and heart problems, nervous disorders, stomach problems as well as joint and spine injuries.

61. Hand-arm or segmental (8 Hz–1 kHz) vibration occurs with hand-held grinders, chippers and other pneumatic tools. Adverse effects include narrowed arteries in the hands and/or arms and damage to the nerve endings. Things that change vibration effects include the vibration frequency, level of insulation, duration of exposure, resistance of the materials and force of grip.

To control the risks, employers need to ensure that:

- purchasing policy focuses on safety
- processes are redesigned to minimise grinding where reasonably practicable
- old tools are replaced with modern vibration reduced tools or are dampened or insulated
- employees take frequent breaks and job rotation is used to reduce exposure.

Electricity

62. Electric shock causes injury or death. A shock can be received through direct contact with live parts, through contact with a medium such as an unearthed tool or when it arcs across a gap. The risk is increased by excessive sweating, as wet skin is more conductive than dry skin.

63. Arcing, explosion or fire often occurs as a result of high fault currents causing burns. Burning and arcing also produce a range of toxic gases, including ozone, cyanide and sulphuric acid. An additional hazard is low oxygen.

To control the risks, employers need to ensure that:

- sources of electrical risk are identified and eliminated
- energy sources are identified and de-energised before machinery maintenance commences
- testing and tagging is scheduled and carried out at least annually
- safety switches are installed and tested regularly
- damaged cords are replaced
- double adaptors, portable power leads and adaptors used on a permanent basis are prohibited
- task-specific protective clothing is worn by employees in the foundry (see page 35)
- thermal imaging or infrared scanning is used to identify electrical problems
- access to high-voltage areas is restricted
- a permit system is in use
- contractors are appropriately supervised.

Machinery that may cause non-mechanical injury

64. Abrasive blasting and rumbling present hazards to employees from airborne contaminants and noise.

To control the risks, employers need to ensure that:

- an exhaust ventilation system is in operation when the enclosure or chamber is occupied, including during cleaning, maintenance and repair work
- exhaust ventilation is designed and installed by a person trained and experienced in industrial ventilation, and includes provision for the routine measurement of static pressure behind each hood
- a procedure is in place so that remedial action is initiated immediately if any faults or defects are identified in the ventilation system
- doors to the enclosure or chamber are closed while blasting or rumbling is in progress
- windows of impact-resistant and shatterproof glass are fitted to chambers to enable occupants to be clearly seen
- enough time for the evacuation of abrasives and dust from the enclosure or chamber is allowed between finishing blasting or rumbling and opening the door (employees must not enter or leave while blasting is taking place)
- controls are operable from inside and outside.

65. Grinders present hazards to employees from airborne contaminants and noise.

To control the risks, employers need to ensure that:

- grinding areas are guarded to minimise exposure of other employees to dust, particles and noise
- hand-held grinders used for process work such as dressing are confined to as few areas in the workplace as reasonably practicable
- facilities for the connection of fixed machines to dust-control equipment are incorporated in guard design
- abrasive wheels on pedestal benches are guarded to control particulates
- tool rests incorporate a tongue piece (enclosing the wheel edge below the rest) to direct particles into the guard or dust control equipment.

Access hazards

66. Access hazards are often complex, involving several risks at the same time, such as chemical dosing in confined spaces or working at height.

67. In addition to the industry-specific controls shown below, duty holders must also comply with Parts 3.2 (Prevention of Falls) and 3.4 (Confined Spaces) of the Regulations and be able to demonstrate the implementation of controls to at least a standard detailed within the 'state of knowledge' relevant to these hazards. WorkSafe's *Prevention of falls in general construction* and *Confined spaces* compliance codes provide further guidance on these matters.

To control the risks, employers need to ensure that:

- suitable platforms, travel restraints and fall-arrest systems are used when employees are working at heights
- employees are educated, trained, monitored and supervised and use a permit system for confined space entry.

Working with molten metal

Foundry layout

68. The layout of the work area needs to take into account the hazards associated with molten metal. Employers need to consider the following issues:

Work flow

To control the risks, employers need to ensure that:

- secondary processes not directly related to furnace work, such as cleaning or rattling finished products, do not take place near furnaces because they restrict movement around furnaces and put employees at additional risk. When it is necessary to conduct a process unrelated to furnace work near a furnace, employers need to ensure employees are protected by barriers and protective clothing (see page 35)
- quarantine procedures are enforced for entry to an operational foundry. The following types of items have to be quarantined due to the hazards they pose when exposed to extreme heat, molten metal, radiation or for personal hygiene reasons:
  - mobile phones, portable radios or MP3 players such as iPods and other battery-operated devices
  - liquid fuels such as cigarette lighters
  - food and food containers, especially open drink containers (food and drink must not be consumed in an operational foundry and fresh water and meal facilities need to be well away from the foundry work environment)
  - personal items such as jewellery and watches, especially if using electromagnetic (induction) based furnaces
- safety checks are developed for both standard work and emergency procedures and they are tested. Emergency procedures, such as first aid and fire drills, should take place at appropriate intervals consistent with the risks at site
- employees do not work under suspended objects such as castings, moulding boxes or ladles
- items that are not being used are stored safely in non-working areas
- drains are checked regularly for water, rusted steel or other materials that may react with molten metal if a spill occurs. If possible, avoid having drains in the foundry area.

Facilities

To control the risks, employers need to ensure that:

- there are sufficient class D fire extinguishers and/or dry sand available for fire fighting as sprinklers and water hoses are prohibited for fire fighting in a casting facility
- amenities such as toilets, shelters, seating, dining rooms, change rooms, drinking water, washing facilities and personal storage are provided for employees. They must be private and secure, adequate for the number of employees and sufficient for the size of the workplace

  In addition, duty holders must also be able to demonstrate the implementation of controls to at least a standard detailed within the 'state of knowledge' relevant to these hazards. See WorkSafe's *Workplace amenities and work environment* compliance code for more information
- safety showers and eyewash stations are easily accessible on an unobstructed path at the same level and near the hazard. Ideally, they would be accessible within 10 seconds, but foundry employers need to balance the requirements of furnace and casting areas against wet areas. This being the case, safety showers and eyewash stations need to be located next to hazards where they do not pose a threat of explosion, and 15-20 metres from furnaces and casting areas. They need to be protected from extremes of temperature, well lit and use high-visibility signage. They need to release a controlled flow of flushing liquid, the nozzles and stored fluid need to be protected from contaminants and they must be tested regularly.

In addition, duty holders must also comply with WorkSafe's *First aid in the workplace* compliance code and be able to demonstrate the implementation of controls to at least a standard detailed within the 'state of knowledge' relevant to these hazards.

Foundry buildings

To control the risks, employers need to ensure that:

- work platforms are horizontal where possible and a minimum of 600mm wide to allow unimpeded movement of employees. The risk of objects falling from the platform needs to be prevented by a wall or in-filled handrail
- the work area is clear of rubbish and hoses, and cords should not cross the floor
- water pipes or fittings that are leaking or dripping are repaired immediately
- aisles need to be open and clear
- flammable and dangerous substances are stored safely to reduce unnecessary exposure of employees to chemical and handling hazards. Cylinders containing gases need to be chained into position (outside furnace areas), with clear and controlled access. They need to be protected from vehicle impact and other shocks and located away from doorways and windows. The area needs to be clear of rubbish and have sufficient lighting and appropriate signage
- cables and pipe work are positioned so they are protected from molten metal splashes
- there are as few ledges and exposed beams as possible – reverse construction or an internal skin wall will also protect services
- the work area is well lit
- a high roof allows natural convection of gases and fumes, along with ventilation allowing adequate air exchange. However, atmospheric monitoring must be carried out to determine if exposure standards are exceeded (see Appendix D)
- the floor surface is safe. Concrete can spall and explode when in contact with molten metal (due to trapped moisture); refractory brick is a safer floor surface for the foundry area
- open pits, deep moulds and other floor openings are securely fenced to prevent employees falling in. The fence may consist of railings, chains and stanchions or a wall. It needs to be at least 900–1100mm in height
- where pits and deep moulds are in permanent use, their internal walls need to be lined with bricks, concrete or other similar material. This lining needs to:
  - retain the shape and safe condition of the pit
  - keep the pit or mould free of moisture and seepage
- pouring pits need to be large enough to safely accommodate a ladle. Clearance of at least 300mm needs to be provided between all parts of, and attachments to, a ladle and the sides of the pit to allow unhindered removal of the ladle
- where an employee is required to stand or work over or near a floor opening, the edge of the opening needs to be covered by substantial grating to prevent them falling into the opening. The grating needs to be flush with the surrounding floor or have ramps to prevent the risk of tripping.

Furnaces

69. Furnaces pose a risk to employees through excessive heat and the potential for mishap.

To control the risks, employers need to ensure that:

- quick and effective shut-off of services to the furnace, such as gas or oil supplies (including hydraulic), is possible
- build-up of explosive gas or fuel is prevented by purging gas-fired and oil-fired furnaces
- physical contact with hot furnaces or furnace parts is prevented by barriers or other means (eg doors that swing, pivot or slide in a way that directs hot surfaces away from employees)
- furnaces have a reservoir to receive run-outs of molten metal in case of refractory failure. If the reservoir is not this large, containment plans need to be devised for controlling and containing metal spills. Reservoirs must be kept clean and dry.

Furnace tools

70. Rusty, cracked, worn and otherwise defective tools (eg ladles, bars and their attachments) can cause bubbling, popping or explosions when introduced to molten metal. Repairs pose additional hazards in the form of airborne contaminants.

71. Modern graphite tools are especially porous and absorb more moisture than traditional tools so they need preheating sufficient to eliminate the moisture.

To control the risks, employers need to ensure that:

- tools are inspected for defects before being used
- tools are kept free of rust
- tools are completely dry before use – they can be stored near a heat source (all tools need to be preheated before use as they are likely to contain some rust, and refractory coatings can also pick up moisture from the atmosphere)
- tools are free of totally enclosed cavities (all cavities should include a vent hole that it is directed away from the operator and positioned to prevent blockage)
- repair and relining of ladles takes place in a designated area with dust extraction.

Raw material inspection

72. Material containing contaminants may trigger a violent reaction when added to molten metal (see page 6). A thorough visual inspection of all materials and packaging before charging will ensure materials are clean, dry and free of corrosion. Hollow objects such as tubes or pipes have the potential to contain moisture. Add these items as the primary charge or return to the supplier. Also see page 6.

To control the risks, employers need to ensure that:

- any materials that will be charged into molten metal are inspected on receipt for contaminants such as:
  - moisture
  - excessive grease and oil
  - corroded or oxidised metal
  - chemicals or unknown substances (any powdery substance needs to be treated as suspect, and residual fertiliser, nitrates and sulphates are particularly dangerous)
- contaminated material is quarantined until it has been cleaned (in cases of heavy contamination or if the source of the contamination cannot be identified, the material needs to be returned to the supplier)
- where possible, porous charge or scrap that may contain moisture is added to the furnace as the primary charge.

Charging metal into the furnace

73. Charging the furnace is one of the most dangerous operations carried out in the foundry, with incidents ranging from minor injuries to fatalities and serious damage to plant and equipment.

74. When using a refractory or crucible-type furnace, carefully check the furnace for cracks or excessive slag build-up. The refractory or crucible needs to be changed or repaired if:

    - there are visible cracks on the inner side walls that provide risk of failure
    - there is a significant skull on the side walls, or
    - metal is seen exiting the drain port.

    Various crucible types are used in foundry processes. It is best to consult with the supplier or manufacturer about maintenance, repair and disposal requirements.

75. If metal is charged into a metal bath, it is important that the metal be dry before immersion into the bath (see preheat charges below). Other important issues to consider when adding metal to a metal bath are:

    - it may be safer to add dry, cracked or suspect metal to a furnace with a dry hearth
    - metal and alloying additions are added gradually to the melt
    - when a charge produces excessive bubbling or small eruptions when added to a melt, the suspect batch of charges is quarantined and inspected for contamination.

To control the risks, employers need to ensure that:

- where reasonably practicable, furnace charging is conducted by mechanical means (if manual aids such as barrows and trolleys are used, they need to be stable and easy for employees to control)
- primary PPE is worn by employees (see page 35).

Preheat charges

76. Water and other materials cause explosions when submerged below the surface of molten metal (see page 6). For this reason, it is safest to assume that all received metal is wet and to preheat it accordingly. The preheat temperature and duration will vary depending on the type of material, the dimensions and the quantity of charge.

77. Control is very important in preheating. Preheating could be done with heat from the furnace by passing charge through hot zones or flues for a predetermined time. Alternatively, hearth type furnaces in which the charge melts through a hearth and joins a pool of molten metal overcomes this problem of moist charge reacting with molten metal. Materials heated around the sides of an older style crucible furnace may not receive sufficient heat and are at risk of prematurely falling into the melt. However, materials stacked in front of newer larger furnaces may receive sufficient heat.

78. Preheated charge can pick up moisture from the atmosphere if there is a delay in using it, so whatever method is chosen, there needs to be a procedure for determining if the materials have been sufficiently preheated before adding to a melt.

79. If charging into an empty furnace or dry hearth, pre-heating may not be required.

To control the risks, employers need to ensure that:

- cracked or suspect metal is added to a furnace with a dry hearth
- sealed or closed sections of scrap and charge that may contain moisture or contaminant are opened
- close-packed blocks and bundles are broken down to facilitate air circulation.

Alloying additions

80. All materials to be charged into molten metal need to be inspected for contamination and cleaned before charging in the same way as for metal (see page 26). Preheating using the same method as for metal is recommended for alloying additions, but there are some exceptions where preheating is not required or not recommended. In all cases, the alloy supplier needs to be consulted for correct practices for addition to metal.

81. Where a substance is to be introduced to molten metal, such as in fluxing, de-gassing or inoculation processes, the substance needs to be clearly identified to avoid the risk of mistaking it for something else. It needs to be presented in a way that allows for its safe addition into the melt.

To control the risks, employers need to ensure that:

- employees who add substances to molten metal are aware of and fully trained in the hazards of adding substances, and are properly supervised by an employee who is aware of and fully trained in the hazards of adding substances.

Fluxing

82. Fluxes can be added to the melt for many reasons, including:
    - to release metal from the dross to the melt
    - to help remove dross from furnace refractory linings
    - to remove inclusions
    - to remove alkali metals such as sodium, lithium and calcium
    - to prevent oxidation or hydrogen pick-up.
83. Many salt-based fluxes easily absorb moisture from the atmosphere and this can result in violent explosions if added to a melt.

To control the risks, employers need to ensure that:

- fluxes are stored in accordance with the manufacturer's instructions
- primary PPE is worn by employees (a respirator may also be required), see page 35.

Dross

84. When skimming the dross, employees handle hot tools and are exposed to molten metal and extreme radiant heat, so there is significant risk of burns and molten metal splashing.

To control the risks, employers need to ensure that:

- moisture and contaminant sources are eliminated
- forklifts used in skimming operations have protective screens fitted to the driver's cabin
- tools and dross pans are clean and dry, have a refractory coating and are preheated before use
- primary PPE is worn by employees (a respirator may also be required), see page 35.

Moving molten metal

85. Precautions need to be taken when moving molten metal around the foundry, regardless of how much metal is being moved.

86. Putting a lid on the transfer vessel when practical is a good way of reducing spills and minimising heat loss.

To control the risks, employers need to ensure that:

- a traffic management plan ensures unnecessary personnel are not in the vicinity of molten metal movements
- where reasonably practicable, mechanical aids are used to transport, position and pour molten metal; and mechanical ladles are fitted with devices to ensure smooth positive control when tilting and pouring to prevent accidental tilting
- where ladles are carried by hand, safe manual handling practices such as two-person lift, safe-grip points and other ergonomic considerations are observed, and all single-hand carried ladles are fitted with a shield or guard that protects the employee from exposure to radiant heat
- the route used to transport molten metal is marked, as short as possible, and clear of other people and objects
- there are no gas or water lines that could cause an explosion if a spill occurred
- the floor is clean, dry and able to withstand molten metal temperatures
- molten metal carriers have right of way
- where molten metal is transported by hand, safe passageways and pouring aisles at least 800mm wide are provided
- employees in the area are notified when molten metal is being moved (eg by flashing lights or horns)
- ladles and transfer vessels are inspected regularly for cracks
- ladles and transfer vessels are preheated before use to remove any moisture absorbed from the atmosphere.

Moving molten metal with a forklift

87. Using a forklift to move crucibles or receptacles of molten metal is a common practice in many foundry operations.

To control the risks, employers need to ensure that:

- forklifts have see-through heat-resistant splashguards (wind/blast shields) fitted between the driver's cabin and the load
- gas line/couplings on gas-powered forklifts are shielded with a heat-resistant guard
- where possible, electric-powered forklifts are used rather than gas or diesel when working with or near molten metal
- forklifts have sufficient load capabilities and sufficient safe lifting and reach requirements
- forklifts use appropriately designed and rated lifting attachment
- forklifts have well-designed, appropriate cabin access and ergonomic seating
- forklifts have solid (not pneumatic) tyres
- forklifts have restraints fitted, which are used by the operator at all times
- forklifts undergo routine maintenance as specified by the manufacturer or supplier, including tyres, tynes and lifting attachments.

Slagging

88. Slagging hazards include heat, hot metal splashes and radiation.
89. If a slagging operation is performed on a ladle that is transported by a crane, the operation could be conducted at a separate station where permanent control measures are installed to protect employees from the hazards of the slagging process.

To control the risks, employers need to ensure that:

- employees are protected by shielding
- ventilation is positioned to draw fumes away from employees rather than through their breathing zone
- primary PPE is worn by employees (see page 35).

Tapping and pouring (casting)

To control the risks, employers need to ensure that:

- employees not directly involved in casting are not present during the operation
- primary PPE is worn by employees (respirator may also be required) in the foundry (see page 35).

Molten metal spills

Containing flow

90. When a metal spill occurs, employee safety must be the primary focus. Boots, shovels or hand tools should not be used to stop the flow. Water must not be used on metal spills.

To control the risks, employers need to ensure that:

- a bucket of clean, dry sand is stored near the furnace, which can be used to stop the flow of spills (if this can be done safely)
- primary PPE is worn by employees (see page 35).

Cleaning up metal spills

91. Before any action is taken to clean up metal spills, the risks of the situation need to be fully assessed. If it is safe to do so, it may be possible to break the metal into sections before it fully solidifies, using a furnace tool. Primary PPE must be worn when doing this (see page 35).
92. If it is unsafe to intervene, the spill will have to be cleaned when the metal has solidified by lifting it from the ground with hand tools. For metal that is more difficult to remove, an oxygen lance may be required. An oxygen lance is an extremely dangerous piece of equipment and extra precautions (such as additional PPE and full training in its use) are required. It is also important to make sure the surrounding area is free of any standing water or flammable materials because molten metal can spray off the lance and onto these items, causing an eruption.

To control the risks, employers need to ensure that:

- a risk assessment is done to determine the safest way to proceed
- surrounding areas are free of water and other contaminants
- primary PPE is worn by employees (see page 35).

Housekeeping

After casting

93. When casting is complete, a number of tasks need to be done to ensure the foundry is safe for the next casting process.

To control the risks, employers need to ensure that:

- the furnace is emptied, cleaned and inspected
- the tools are cleaned and recoated.

Cleaning dusts

94. Compressed air must not be used for cleaning unless the task cannot be done any other way. If compressed air is used, control measures such as reducing air pressure and providing protective equipment need to be in place. **Compressed air must never be used to clean clothing or the body**. Also see page 9.

To control the risks, employers need to ensure that:

- work practices and equipment produce a minimum of residue
- plant, fixtures and structures are cleaned regularly
- sand or earth floors in foundries are appropriately managed to prevent dust rising. If this involves using moisture, the sand or earth floors should not be wet enough to trigger a steam explosion
- dust extraction is by exhaust ventilation
- they use technologies such as fogging to reduce dust. However, consideration needs to be given to the impact on the environment (eg humidity and heat stress and other risks associated with increases in atmospheric moisture)
- wet cleaning takes place where it presents no additional risk
- employees use vacuum cleaners with high efficiency particulate air (HEPA) filters
- cleaning is a regular part of preventative maintenance programs.

Equipment storage

To control the risks, employers need to ensure that:

- equipment such as moulding boxes, patterns and equipment that are stacked are stable and free from dangerous projections
- furnace tools are stored so they are clean and dry and off the floor in suitable racks at a height that is easily accessible.

Material storage

To control the risks, employers need to ensure that:

- materials are inspected and then stored in clearly labelled containers in permanent specifically designated areas that are clean and dry
- metal charges and materials that will come into contact with molten metal are kept undercover to prevent the absorption of moisture
- containers include holes or other design features to facilitate drainage and prevent the accumulation of contaminants such as oil or water
- process materials and substances are stored in separate containers, process residues are stored safely and in a manageable form and materials that are not used in the process are stored separately from the process materials
- materials not suited for use in molten metal are not stored with the raw materials or in the foundry area
- a register describing hazards and symptoms of exposure to materials and substances found in the workplace is created and maintained.

Personal protective equipment in the foundry

Figure 2: Cotton shirt after molten metal pour

In areas where the molten metal was trapped or rested against the material – such as pockets, button holes, inside gloves or at the waistband of pants – it burnt through rapidly and in some instances caught alight. The burnt edges smouldered until physically stamped out.

Figure 3: Wool viscose shirt (one example of a flame-resistant fabric) after molten metal pour

Wool viscose does not burn through as quickly, giving the wearer time to remove the clothing before further injury occurs and providing increased protection from molten metal splashes.

95. Employers must ensure that PPE is supplied to all employees, including labour hire staff and contractors. It must be replaced when it is no longer capable of providing the necessary protection (eg it is damaged or worn).

96. For foundry purposes, compliance is demonstrated by employers supplying the two categories of PPE to employees in conjunction with a program for managing PPE:

- **Primary protective clothing** is used for specific hazardous tasks then removed. It provides protection from hazards such as metal splash and radiant heat. The garments need to be made from inherently fire-retardant fabrics to ensure their protective properties are intact as long as the garment is intact. They need to be comfortable to wear and breathable in very extreme work conditions. Leather options offer some durability and protective benefits but can compromise comfort and add to heat stress in certain situations (see table on page 36).
- **Secondary protective clothing** is all-day/everyday clothing. The clothing needs to be fire-retardant and the choice of inherent or treated can take comfort and cost into account, but these garments are the last defence for the body if primary protection fails. A cotton fabric is the minimum requirement, but specially treated cotton or wool fabric is recommended (see table on page 36).

97. There are two classes of fire-retardant clothing:

- **Treated** garments require additional attention to preserve their protective properties such as particular cleaning or protection from some kinds of chemicals or excessive heat. Many have limited life spans or efficacy that declines over time.
- **Inherent/permanent** garments do not require special care to preserve their protection. Their protection lasts as long as the garment does.

98. Garments are designed to withstand fire and shed molten metal quickly and effectively. Badly fitted garments can create folds that catch and hold the metal, making them less protective.

99. Style is also important – for example pockets and flaps create catch points, metal buttons heat up from radiant heat and fire-retardant tape can stop the fabric breathing and cause sweat/burn marks if not placed well on a garment. High-visibility colour options can assist with site visibility.

The information given below is a guide only. Different metals and foundry processes have different PPE requirements. See Appendix F for selection of appropriate PPE.

Primary and secondary PPE

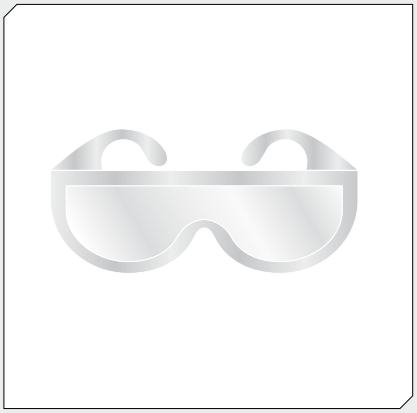
Primary PPE for molten metal work (in addition to secondary PPE)	Secondary PPE for general foundry work

HEAD
Use helmets where there is potential for items to fall from height or where work takes place above head height (eg on a mezzanine). Industrial safety helmets should be considered. Where tasks result in dust or particulates, a head covering should be considered.

EARS
The factors that need to be taken into account when selecting hearing protectors need to include compliance with AS 1270, level of noise, the wearer (eg personal characteristics, comfort), communication requirements, and compatibility with the job/workplace. Guidance on hearing protectors is provided in AS/NZS 1269.3.

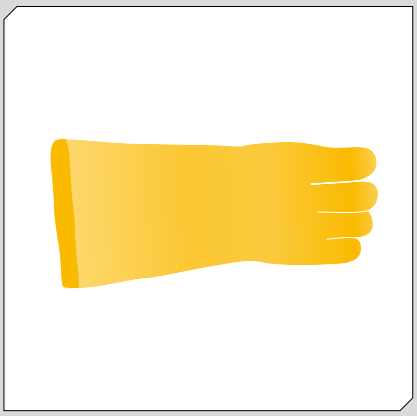
EYES AND FACE
Face shields with neck protection.

EYES AND FACE
Industrial safety glasses with side shields are the minimum.



RESPIRATORY
Respiratory protective devices (RPD) used need to comply with AS/NZS 1716. The type of respirator selected needs to take into account the operator (ie facial hair, physiological and psychological factors), the task (ie how the job is done, duration, frequency) and the substance (ie type of contaminant, concentration). The standard AS/NZS 1715 provides guidance on the selection, use and maintenance of respiratory protective devices. Guidance can also be obtained from suppliers of respiratory protective equipment.

Primary and secondary PPE

Primary PPE for molten metal work (in addition to secondary PPE)	Secondary PPE for general foundry work
TRUNK AND ARMS A jacket of leather or other suitably resistant material must be worn outside all other clothing. It must be free of features such as cuffs and pockets that may trap molten metal. It must be worn properly and fastened at all times.	**TRUNK AND ARMS** Long-sleeved shirt made from flame-resistant fabric such as wool, heavy cotton drill, Firewear, TuffWeld and Indura, or fabrics with flame-retardant coatings such as FlameShield, aramid or Trevira CS. Employers must provide reflective clothing where there is a risk radiation and heat may affect health. Garments need to fasten at the neck and wrists to prevent molten metal splashes, dust, chemicals and other substances from entering through the collar and cuffs.
HANDS Heat-resistant Kevlar or heavy leather gauntlets that cover the lower part of arm. 	**HANDS** Gloves selected need to take into account the hazard (eg burns, abrasion, chemicals, cuts), the work environment and the wearer (eg fit, comfort, dexterity). Guidance on the selection, use and maintenance of protective gloves is provided in AS/NZS 2161.1. 
LEGS Where risk of molten metal spills or splashes exists, trousers of leather or other suitably resistant materials must be worn. The trousers need to cover the top of the footwear and be free of features such as cuffs and pockets that may trap molten metal.	**LEGS** Heat-resistant trousers.

FEET
Employees must wear safety footwear at all times in the workplace unless a legally qualified medical practitioner certifies that wearing safety footwear would injure the wearer. In such cases, the reason for such an opinion must be given and the most appropriate alternative protective equipment sought.

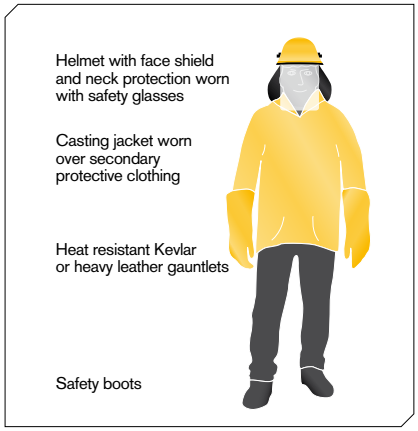


Figure 4: Primary protective clothing (Molten metal work)

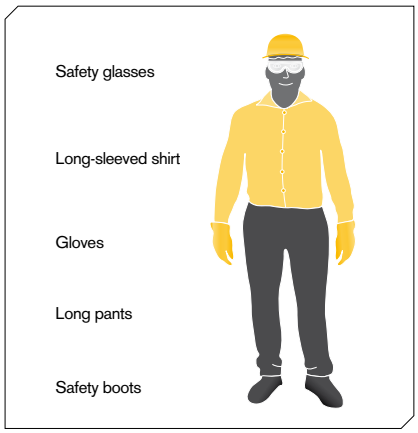


Figure 5: Secondary protective clothing (General foundry work)

Storage and care of protective equipment

100. For foundry purposes, compliance is demonstrated by employers ensuring that:

- all protective equipment and clothing provided is maintained in sound condition, tested routinely and capable of performing the protective functions for which it was provided
- employees are trained in the need for, effective use and care of, and means of testing the fit of protective equipment (when trained employees must cooperate in the care and maintenance of the equipment)
- equipment and clothing is only worn by the employee to whom it was issued, and is marked with the name of that employee
- clean storage is provided for all protective equipment and clothing
- maintenance of clothing and equipment is conducted when required and in the manner prescribed by the manufacturer or supplier.

Appendices

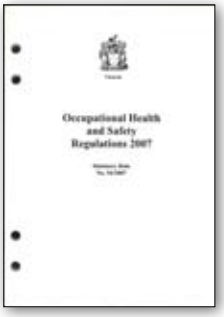
Appendices

Appendix A – The compliance framework

Occupational Health and Safety Act 2004

Act No. 107/2004

The ***Occupational Health and Safety Act 2004*** (the OHS Act) sets out the key principles, duties and rights in relation to occupational health and safety (OHS).



Occupational Health and Safety Regulations 2007

Statutory Rule No. 54/2007

The **Occupational Health and Safety Regulations 2007** (the Regulations) specify the way in which a duty imposed by the OHS Act must be performed, or prescribe procedural or administrative matters to support the OHS Act (eg requiring licences for specific activities, the keeping of records or giving notice).

Compliance codes provide practical guidance to duty holders. If a person complies with a provision of a compliance code, they are deemed to comply with the OHS Act or Regulation duty covered by the code provision. However, compliance codes are not mandatory, and a duty holder may choose to use some other way to achieve compliance.

WorkSafe Positions are guidelines made under section 12 of the OHS Act that state how WorkSafe will apply The OHS Act or Regulations or exercise discretion under a provision of the OHS Act or Regulations. WorkSafe Positions are intended to provide certainty to duty holders and other affected parties.

Non-statutory guidance includes information published by WorkSafe aimed at building people's knowledge and awareness of OHS issues, risks to health and safety, and the disciplines and techniques that can be applied to manage and control risks. Non-statutory guidance is not mandatory, nor does it provide any 'deemed to comply' outcomes for duty holders. This guidance does, however, form part of the 'state of knowledge' about OHS.

Appendix B – Definitions

Charge

Material to be added to the furnace, such as pre-cast ingots, metal scrap, virgin metal material and various melting agents, such as fluxes.

Dangerous goods

Specific substances listed in Appendix 2 of the Australian Code for Transport of Dangerous Goods by Road and Rail or satisfy the criteria of columns 2, 7 or 9 in the appendix; or are determined to be dangerous goods under paragraph 1.18 of the Code or satisfy the UN dangerous goods tests and criteria for dangerous goods (as defined by the *Dangerous Goods Act 1985*).

Dry hearth

One that does not contain liquid metal.

Ferrous foundry

A foundry that produces castings of iron or steel.

Hazardous substance

A substance listed on the Australian Safety and Compensation Council's 'Hazardous Substances Information System', or which meets the criteria in the Approved Criteria for Classifying Hazardous Substances (as defined by the Regulations). The substance can be solid, liquid or gas, and when used in the workplace is often in the form of gases, vapours, fumes and dusts.

Manual handling

Any activity requiring the use of force exerted by a person to lift, lower, push, pull, carry or otherwise move, hold or restrain any object (as defined by the Regulations).

Material safety data sheet (MSDS)

A document that provides the information needed to ensure the safe handling of hazardous substances, prepared by the manufacturer or importing supplier (as defined by the Regulations). Information on the properties of the substance, its toxicity, reactivity and precautions for safe use are included in an MSDS.

Non-ferrous foundry

Produce castings based on copper, aluminium, lead, zinc, nickel, magnesium and other non-ferrous metals.

Personal protective equipment (PPE)

Equipment or clothing used to provide personal protection such as gloves, gauntlets, safety glasses, helmet, goggles, earmuffs, safety shoes, respirators or fall arrest systems.

Plant

Any machinery, equipment, appliance, implement and tool, any component of any of those things, and anything fitted, connected or related to any of those things (as defined by the *OHS Act*).

Short-term exposure limit (STEL)

A 15-minute time weighted average (TWA) exposure that should not be exceeded at any time during a working day even if the eight-hour TWA average is within the TWA exposure standard. Exposures at the STEL should not be longer than 15 minutes and should not be repeated more than four times per day. There should be at least 60 minutes between successive exposures at the STEL (as defined by the Australian Safety and Compensation Council).

Time weighted average (TWA)

The average airborne concentration of a particular substance when calculated over a normal eight-hour working day, for a five-day working week (as defined by the Australian Safety and Compensation Council).

Appendix C – Consultation

By law, employers must consult with employees on a range of matters that directly affect (or are likely to directly affect) their health and safety, so far as is reasonably practicable.

Consultation must involve sharing information with employees, giving the employees a reasonable opportunity to express their views and taking those views into account.

Where employees are represented by HSRs, these representatives must be involved in the consultation, so far as reasonably practicable.

The law sets out specific requirements on how HSRs are to be involved in consultation. These are as follows:

- Provide HSRs with all the information about the matter that the employer provides, or intends to provide, to employees. If it is reasonably practicable, the information must be provided to the HSRs a reasonable time before it is provided to employees.
- Invite the HSRs to meet with the employer to consult on the matter or meet with the HSRs at their request.
- Give the HSRs a reasonable opportunity to express their views on the matter and take those views into account.

The employer must include independent contractors and their employees in the consultation, so far as is reasonably practicable, if the employer has, or should have, control of a relevant matter that affects their health and safety.

Consultation is required when:

- identifying or assessing hazards or risks
- making decisions on how to control risks
- making decisions about the adequacy of facilities for employee welfare (such as dining facilities, change rooms, toilets or first aid)
- making decisions about procedures to:
  - resolve health and safety issues
  - consult with employees on health and safety
  - monitor employee health and workplace conditions
  - provide information and training
- determining the membership of any health and safety committee in the workplace
- proposing changes that may affect employee health and safety, such as changes to:
  - the workplace
  - plant, substances or other things used in the workplace
  - the work performed at the workplace
- doing any other thing prescribed by the Regulations.

In practice, this means that when planning to implement measures identified in this compliance code, or when making decisions to implement alternative measures to those specified in this compliance code, consultation must take place.

Appendix D – Hazardous substances: exposure standards, atmospheric monitoring and health surveillance

Exposure standards

Employers are required to ensure that no employee is exposed to an airborne level of a hazardous substance that is above the national exposure standard as set out by the Australian Safety and Compensation Council (ASCC).

Exposure standards represent airborne concentrations of substances in a person's breathing zone, which according to current knowledge, should not impair employees' health or cause them undue discomfort. Exposure standards do not represent a fine line between safe and unsafe. Therefore exposure to airborne contaminants needs to be reduced so far as reasonably practicable and not just below the exposure standard.

The latest information on exposure standards for hazardous substances should be periodically referred to and can be found in the HSIS database on the ASCC website **hsis.ascc.gov.au**.

Atmospheric monitoring

Atmospheric monitoring is required where there is an exposure standard for the airborne contaminant and there is uncertainty, based on reasonable grounds, as to whether the exposure standard is or may be exceeded. This means that if it is clear or obvious that exposure is not significant and therefore not likely to exceed the exposure standard, monitoring is not required. Similarly, atmospheric monitoring is not required if it is obvious that exposure is excessive. In this case, the employer needs to eliminate or control the risk so far as is reasonably practicable.

Personal monitoring in an employee's breathing zone is considered the most appropriate monitoring technique.

Examples of situations where there may be uncertainty or where atmospheric monitoring may be needed include:

- the process or hazardous substance is new and there is uncertainty as to the level of exposure or risk
- the process is carried out sporadically or the exposure varies in level, frequency or duration
- it is not clear whether new or existing risk controls are effective (eg ventilation)
- the risk to health is largely controlled through the use of respiratory protection
- the risk to health is largely managed through administrative controls (ie safe work practices or systems of work such as job rotation)
- there is evidence that the risk controls have deteriorated as a result of poor maintenance
- process modifications or changes in work practices have occurred that may affect exposure.

Atmospheric monitoring only tests for potential exposure through inhalation and may not always represent an employee's actual total exposure, particularly where skin absorption or ingestion is a significant route of exposure such as with exposure to lead.

Atmospheric monitoring for a hazardous substance is not required under the Regulations if health surveillance is also required for that substance and the health surveillance includes biological monitoring. This is because biological monitoring takes into account all routes of exposure (ingestion, inhalation and skin absorption), while atmospheric monitoring only considers exposure through inhalation. Health surveillance through biological monitoring is therefore considered the more appropriate method of assessing employee exposure and it can determine the effectiveness of all controls including personal protective equipment.

Atmospheric monitoring and the interpretation of the results (including comparison with the relevant exposure standards) needs to be undertaken by a competent person with appropriate training and experience, such as an occupational hygienist or other safety professional.

Action required after atmospheric monitoring

If the results of atmospheric monitoring indicate that control measures have deteriorated or are not effective, prompt action must be taken to reduce employee exposure to the airborne contaminants. Control measures need to be restored or improved as soon as possible. This may involve repairing existing controls, providing portable or temporary ventilation, adopting modified work practices, providing personal protective equipment (PPE) or ceasing work while normal control measures are restored to the required level of effectiveness.

If the results of atmospheric monitoring show that the level of exposure is below the recommended exposure standard, an employer needs to consider whether it is reasonably practicable to reduce exposure further as exposure standards do not represent a fine line between safe and unsafe.

The Regulations require you to provide the results of atmospheric monitoring to all employees on whom personal monitoring was conducted and to any employee who has been, or has the potential to be, exposed to the substances. It is important that all monitoring results are communicated to the employees involved, regardless of whether the results indicate excessive or minimal employee exposure to the substances.

Keeping records of atmospheric monitoring

An employer is required to keep the results of all monitoring for 30 years unless WorkSafe specifies a lesser period. The records of monitoring may be kept in any form, as long as the information contained in them is accessible to any employee who has been or may be exposed to the substance.

Health surveillance

Health surveillance is the process of monitoring the health or exposure of employees exposed to certain hazardous substances for which there are known and acceptable health surveillance procedures.

Health surveillance involves medical examination (eg lung function tests, x-rays, skin examination) and may include biological monitoring (eg blood or urine tests) to test for a change or to test for the substance or its metabolites ('breakdown products').

The main purpose of health surveillance is to detect adverse changes to health due to occupational exposure to substances or to detect excessive absorption of substances.

The Regulations require employers to provide health surveillance for employees when:

- they are exposed to a 'scheduled' hazardous substance, or a substance determined by WorkSafe to require health surveillance and
- there is a reasonable likelihood of an adverse health effect occurring under the particular conditions of use.

The 'scheduled' hazardous substances are substances listed in Schedule 3 to the National Model Regulations for the Control of Workplace Hazardous Substances (except asbestos) or a substance determined by WorkSafe to require health surveillance. There are 15 substances listed in Schedule 3 of the National Model Regulation (as shown below). It should be noted that the schedule may be amended from time to time.

- acrylonitrile
- inorganic arsenic
- benzene
- cadmium
- inorganic chromium
- creosote
- isocyanates
- inorganic mercury
- 4,4'-methylene bis 2-chloroaniline (MOCA)
- organophosphate pesticides
- pentachlorophenol (PCP)
- polycyclic aromatic hydrocarbons (PAH)
- crystalline silica
- thallium
- vinyl chloride

Some examples of situations where there may be a reasonable likelihood of adverse health effects and therefore where health surveillance may be required are as follows:

- there is significant exposure to the particular substance and the risk to health is largely or primarily controlled through what are considered less effective controls such as personal protective equipment (PPE) or administrative controls (eg safe work procedures)
- symptoms have been reported which are likely to be related to the use of the substance
- incidents or near misses (eg spillages) have occurred that have resulted in significant exposure
- there is evidence that control measures have deteriorated significantly as a result of poor maintenance.

The Australian Safety and Compensation Council (National Occupational Health & Safety Commission) provides guidance on the health surveillance requirements for each of the substances listed above.

Lead

Where employees are working in a lead-risk job, Subdivision 3 (Lead-risk jobs) in Part 4.4 – Lead of the Regulations requires the employer to arrange biological monitoring. This means the employer must arrange for blood tests to be done to determine employees' blood lead levels.

Appendix E – Dangerous goods in foundry operations

Substance	Foundry use	Class	Sub-risk	Acute hazards
Aluminium dross	By product of smelting process	4.3	–	Contact with water may cause heating and flammable gases such as hydrogen and/or toxic gases such as ammonia
Aluminium liquid	Molten metal	9	–	Burns, explosion risks
Carbon dioxide	Silicate binder in core making	2.2	–	Asphyxiant, stored under pressure in cylinders
Chlorine	Degassing agent for use with non-ferrous alloys	2.3	8	Heavier than air, toxic, corrosive gas, stored under pressure in cylinders
Dimethylene Amine (DMEA)	Catalyst for cold box binder systems	2.1	2.3	Fire, explosion risk, shock/friction sensitive, flammable, toxic gas
Formaldehyde	Resinous binders in moulding	3	–	Flammable liquid
Furfuryl alcohol	Added to ureaformaldehyde systems in moulding	6.1	–	Toxic, also C1 combustible liquid
Methyl formate	Core/mould making binder	3	–	Highly flammable, low boiling point, drums may rupture if stored above boiling point
Oxygen	Injected into furnace	2.2	5.1	Oxidising gas, accelerates combustion
Phosphoric acid	Furan resin catalyst	8	–	Corrosive
Sulphur dioxide	Catalyst in cold box binder system	2.3	8	Heavier than air toxic gas, corrosive
Toluene	Solvent used in core washing	3	–	Flammable liquid
Triethylamine	Catalyst	3	8	Highly flammable, corrosive liquid
Xylene	Solvent in core washing	3	–	Flammable liquid

Appendix F – Effective PPE program

It is the employer's responsibility to provide personal protective equipment (PPE) for all employees, including labour hire workers and contractors.

Due to the harsh nature of foundry work, PPE is often required in addition to other control measures. The adverse environmental conditions mean that an effective program for managing PPE is required.

While PPE is the last line of defence when other controls fail, it may not always be an appropriate control for every hazard, for example manual handling.

Step 1: Selection of PPE

This checklist identifies factors that may need to be addressed when using protective clothing and equipment as a risk control. Answers in a red box indicate that the protective clothing and equipment may not be suitable.

Selection checklist	Yes	No
Is there protective clothing and equipment that will effectively protect employees?		
Is this protective clothing and equipment readily available?		
Will the protective clothing and equipment interfere with vision and communication?		
Will any exposed employees be unable to use the protective clothing and equipment due to physical, psychological or medical factors?		
Will the protective clothing and equipment interfere with the job or task?		
Will using protective clothing and equipment create other risks; for example, manual handling or heat stress?		

Step 2: Implement an effective PPE program

When protective clothing and equipment is used on an ongoing basis, a management program needs to be in place and reviewed regularly.

This checklist contains the essential requirements of an effective program and can be used to evaluate an existing program. Answers in a green box indicate the requirement has been satisfied.

Requirement	Yes	No	N/A
Did the employer establish the program?			
Did the employer consult employees and HSRs when establishing the program?			
Are employees and HSRs active participants in the program and involved in its planning, implementation, monitoring and evaluation?			

Requirement	Yes	No	N/A
Is someone designated to be responsible for the program?			
Does that person have the full support of employees and the employer?			
Is there an effective procedure for dealing with situations where clothing and equipment are not being used as required?			
Does the procedure for selecting protective clothing and equipment include consultation?			
Respirators place additional strain on cardio and respiratory systems. Is there a program of medical screening to determine whether employees are physically and psychologically fit enough to use them?			
Are employees and supervisors (including labour hire workers and contractors) appropriately trained in: • the program • the risks, dangers and need for protection • when, where and how the clothing and equipment is to be used • proper use and fitting • how to test the equipment (eg respirators) • cleaning, storage, maintenance and replacement • the limitations of the equipment and clothing • how any problems/issues with the equipment and its use are to be reported and fixed • future risk controls that will enhance the use of protective clothing and equipment?			
Is clothing and equipment supplied to each employee?			
Are the following considerations met when selecting protective clothing and equipment: • is it comfortable and a good fit • does it cause interference with the job • does it provide employees with choice • does it cater for differences between employees • does it provide adequate levels of protection • can it be used together with other clothing and equipment?			
Do employees get a copy of the operator's manual for the clothing and equipment provided?			

Requirement	Yes	No	N/A
Is there proper fitting and testing of clothing and equipment?			
Is there regular cleaning/disinfecting of clothing and equipment?			
Is proper no-contamination storage for the clothing and equipment available?			
Is there periodic inspection and maintenance of the equipment and/or replacement as required and as per the manufacturer's/supplier's instructions?			
Is there adequate employee time allocated for training, fitting, cleaning and rest breaks (if necessary) when using some equipment?			
Are there procedures for non-routine situations, such as spills and leaks?			
Is there regular assessment of the program to ensure procedures are being followed and employees are being properly protected?			

Step 3: Review the PPE program

To be effective, the program needs to be re-evaluated regularly. This includes yearly reviews of:

- changes in knowledge about the hazard
- existing risks and any new risks due to changes in work processes
- changes in technology and state of knowledge about risk-control measures, including elimination, substitution, engineering controls and changing systems of work or work practices
- changes in technology and state of knowledge about protective clothing and equipment
- the workplace's protective clothing and equipment program.

Appendix G – Further information

The Australian Standards and other references listed below are not incorporated into this compliance code. This means that they do not form part of this compliance code, although they may have regulatory status in their own right. They are included only to provide an indication of sources of further information.

Hazardous substances

Safe Handling of Industrial Waste: A practical guide for workplaces (WorkSafe)

Dangerous goods

AS/NZS 1020:1995 – *The control of undesirable static electricity*

AS 1216-2006 – *Class labels for dangerous goods*

AS 1319-1994 – *Safety signs for the occupational environment*

AS 1345-1995 – *Identification of the contents of pipes, conduits and ducts*

AS/NZS 1596:2008 – *Storage and handling of LP gas*

AS 1674.1:1997 – *Safety in welding and allied process – fire precautions*

AS1678.8A1-2004 – *Emergency procedure guide – Transport – Group text EPGs for class 8 substances – Corrosive substances*

AS 1692-2006 – *Steel tanks for flammable and combustible liquids*

AS 1894-1997 – *Storage and handling of non-flammable cryogenic and refrigerated liquids*

AS 1940-2004 – *The storage and handling of flammable and combustible liquids*

AS/NZS 2022:2003 – *Anhydrous ammonia – Storage and handling*

AS 2030.1-1999 – *The verification, filling, inspection, testing and maintenance of cylinders for storage and transport of compressed gases – Cylinders for compressed gases other than acetylene*

AS 2030.2-1996 – *The Verification, filling, inspection, testing and maintenance of cylinders for storage and transport of compressed gases – Cylinders for dissolved acetylene*

AS/NZS 2243.1:2005 – *Safety in laboratories – Planning and operational aspects*

AS/NZS 2243.2:2006 – *Safety in laboratories – Chemical aspects*

AS/NZS 2243.10:2004 – *Safety in laboratories – Storage of chemicals*

AS 2359.12-1996 – *Powered industrial trucks – Hazardous areas*

AS/NZS 60079.10.2004 – *Electrical apparatus for explosive gas atmospheres – Classification of hazardous areas*

AS/NZS 2430.3.1:2004 – *Classification of hazardous areas – Examples of area classification – General*

AS/NZS 2430.3.2:2004 – *Classification of hazardous areas – Examples of area classification – Vehicle workshops, vehicle parking, fuel dispensing stations and aircraft hangers*

AS/NZS 2430.3.3:2004 – *Classification of hazardous areas – Examples of area classification – Flammable liquids*

AS/NZS 2430.3.4:2004 – *Classification of hazardous areas – Examples of area classification – Flammable gases*

AS/NZS 2430.3.5:2004 – *Classification of hazardous areas – Examples of area classification – Refineries and major processing plants*

AS/NZS 2430.3.6:2004 – *Classification of hazardous areas – Examples of area classification – Laboratories including fume cupboards and flammable medical agents*

AS/NZS 2430.3.8:2004 – *Classification of hazardous areas – Examples of area classification – Surface coatings and adhesives*

AS/NZS 2430.3.9:2004 – *Classification of hazardous areas – Examples of area classification – Miscellaneous*

AS 3780-2008 – *The storage and handling of corrosive substances*

AS/NZS 3833:2007 – *The storage and handling of mixed classes of dangerous goods, in packages and intermediate bulk containers*

AS/NZS 4452:1997 – *The storage and handling of toxic substances*

AS/NZS 4681:2000 – *The storage and handling of class 9 (miscellaneous) dangerous goods and articles*

AS/NZS 4745:2004 – *Code of practice for handling combustible dusts*

Personal Protective Equipment

AS/NZS 1336:1997 – *Recommended practices for occupational eye protection*

AS/NZS 1337:1992 – *Eye protectors for industrial applications*

AS/NZS 1338.1:1992 – *Filters for eye protectors – Filters for protection against radiation generated in welding and allied operations*

AS/NZS 1338.2:1992 – *Filters for eye protectors – Filters for protection against ultraviolet radiation*

AS/NZS 1338.3:1992 – *Filters for eye protectors – Filters for protection against infra-red radiation*

AS/NZS 1800:1998 – *Occupational protective helmets – Selection, care and use*

AS/NZS 1801:1997 *Occupational protective helmets*

AS/NZS 2161.1:2000 *Occupational protective gloves – Selection, use and maintenance*

AS/NZS 2161.2:2005 *Occupational protective gloves – General requirements*

AS/NZS 2161.3:2005 *Occupational protective gloves – Protection against mechanical risks*

AS/NZS 2161.4:1999 *Occupational Protective Gloves – Protection against thermal risks (heat and fire)*

AS/NZS 2161.9:2002 *Occupational protective gloves – Method of measurement and evaluation of the vibration transmissibility of gloves at the palm of the hand*

AS/NZS 2210.1:1994 – *Occupational protective footwear – Guide to selection, care and use*

AS/NZS 2210.2:2000 – *Occupational protective footwear – Requirements and test methods*

AS/NZS 2210.3:2000 – *Occupational protective footwear – Specification for safety footwear*

AS/NZS 2210.4:2000 – *Occupational protective footwear – Specification for protective footwear*

AS/NZS 2210.5:2000 – *Occupational protective footwear – Specification for occupational footwear*

AS/NZS 2210.6:2001 – *Occupational protective footwear – Additional requirements and test methods*

AS/NZS 2210.7:2001 – *Occupational protective footwear – Additional specifications for safety footwear*

AS/NZS 2210.8:2001 – *Occupational protective footwear – Additional specifications for protective footwear*

AS/NZS 2210.9:2001 – *Occupational protective footwear – Additional specifications for occupational footwear*

AS/NZS ISO 2801:2008 – *Clothing for protection against heat and flame – General recommendations for selection, care and use of protective clothing*

AS/NZS 4501.1:2008 – *Occupational protective clothing – Guidelines on the selection, use, care and maintenance of protective clothing*

Plant and machinery

AS 4024.1-2006 Series – *Safety of Machinery*

AS 1657-1992 – *Fixed Platforms, walkways, stairways and ladders – Design, construction and installation*

Machinery and equipment safety – an introduction (WorkSafe)

Planning for safer plant operations: A toolkit for safe maintenance, repair, installation, servicing and cleaning of machinery and equipment (WorkSafe)

Airborne contaminants

AS 1319-1994 – *Safety signs for the occupational environment*

AS/NZS 1336:1997 – *Recommended practices for occupational eye protection*

AS/NZS 1337:1992 – *Eye protectors for industrial applications*

AS/NZS 1715:1994 – *Selection, use and maintenance of respiratory protective devices*

AS/NZS 1716:2003 – *Respiratory protective devices*

AS 4775-2007 *Emergency eyewash and shower equipment*

Noise

AS 1319-1994 – *Safety signs for the occupational environment*

AS/NZS 1269.0:2005 – *Occupational noise management – Overview and general requirements*

AS/NZS 1269.1:2005 – *Occupational noise management – Measurement and assessment of noise immission and exposure*

AS/NZS 1269.2:2005 – *Occupational noise management – Noise control management*

AS/NZS 1269.3:2005 – *Occupational noise management – Hearing protector program*

AS/NZS 1269.4:2005 – *Occupational noise management – Auditory assessment*

AS/NZ 1270:2002 Acoustics – *Hearing protectors*

Vibration

AS 2670.1-2001 – *Evaluation of human exposure to whole body vibration – General requirements*

AS 2763-1988 – *Vibration and shock – Hand-transmitted vibration – Guidelines for measurement and assessment of human exposure*

Electricity

AS 1674.2:2007 – *Safety in welding and allied process – electrical*

AS/NZS 2381.1:2005 – *Electrical equipment for explosive atmospheres – Selection, installation and maintenance – General requirements*

AS 2381.6-1993 – *Electrical equipment for explosive atmospheres – Selection, installation and maintenance – Increased safety*

AS 2381.7-1989 – *Electrical equipment for explosive atmospheres – Selection, installation and maintenance – Intrinsic safety*

AS 2763-1988 – *Vibration and shock – Hand-transmitted vibration – Guidelines for measurement and assessment of human exposure*

AS/NZS 3760:2003 – *In-service safety inspection and testing of electrical equipment*

Health Surveillance

Guidance Note on the Interpretation of Exposure Standards for Atmospheric Contaminants in the Occupational Environment [NOHSC: 3008 (1995)] 3rd Edition (Australian Safety and Compensation Council)

Guidelines for Health Surveillance [NOHSC: 7039 (1995)] (Australian Safety and Compensation Council)

National Code of Practice for the control of workplace hazardous substances [NOHSC: 2007 (1994)] (Australian Safety and Compensation Council)

National Model Regulations for the Control of Workplace Hazardous Substances [NOHSC: 1005(1994)] (Australian Safety and Compensation Council)

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