Compliance code

Metal casting

Contents

Preface

This compliance code (**Code**) provides practical guidance for those who have duties or obligations under the *Occupational Health and Safety Act 2004* (**OHS Act**) and Occupational Health and Safety Regulations 2017 (**OHS Regulations**) in relation to metal casting.

The Code was developed by WorkSafe Victoria (**WorkSafe**). Representatives of employers and employees were consulted during its preparation. It was made under the OHS Act and approved by Ingrid Stitt, Minister for Workplace Safety.

Duty holders under the OHS Act and OHS Regulations should use this Code together with this legislation. This Code replaces the Foundries compliance code 2008 which is no longer in force and effect.

While the guidance provided in the Code is not mandatory, a duty holder who complies with the Code will – to the extent it deals with their duties or obligations under the OHS Act and OHS Regulations – be taken to have complied with those duties or obligations.

If conditions at the workplace or the way work is done raise different or additional risks not covered by the Code, compliance must be achieved by other means. WorkSafe publishes guidance to assist with this at **worksafe.vic.gov.au**.

Failure to observe the Code may be used as evidence in proceedings for an offence under the OHS Act or OHS Regulations. However, a duty holder will not fail to meet their legal duty simply because they have not followed the Code.

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

A health and safety representative (**HSR**) may cite the Code in a provisional improvement notice when providing directions on how to remedy an alleged contravention of the OHS Act or OHS Regulations. Approval for the Code may be varied or revoked by the Minister. To confirm the Code is current and in force, go to **worksafe.vic.gov.au**.

Part 1- Introduction

Purpose

1. The purpose of this Code is to provide practical guidance to duty holders about how to comply with their duties under the OHS Act and OHS Regulations in relation to metal casting work.

Scope

2. This code provides information for duty holders about meeting their obligations under the OHS Act and OHS Regulations in relation to work that involves the casting of molten metal, including preparatory and finishing processes.

3. This Code also provides information about how to identify and control the risks associated with metal casting work. Because of the diverse and hazardous nature of the work environment, metal casting presents a range of risks, including:

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

4. The Code provides practical guidance on metal casting specific hazards but also refers to other hazards related to metal casting work. Risk controls set out 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 certain metal casting operation, a duty holder needs to implement controls that achieve the same health and safety outcomes by applying the approach shown in Part 2 – Overview of the risk management process. Where hazards are subject to specific regulation (eg hazardous substances), the specific regulation must be used on for compliance to be achieved.

5. It is not possible for this Code to deal with every risk arising during metal casting work that a duty holder may encounter at their workplace. The guidance in the Code needs to be considered with regard to the particular characteristics and circumstances of the workplace.

Application

6. This code is primarily aimed at employers, self-employed persons and those with management and control of workplaces in metal casting operations. It may also be of assistance to employees, health and safety representatives (HSRs) and consultants who work in the metal casting industry.

> **Note:** The word **must** indicates a legal requirement that has to be complied with. The words **need(s) to** are used to indicate a recommended course of action in accordance with duties and obligations under Victoria's health and safety legislation. The word **should** is used to indicate a recommended optional course of action.

What is metal casting work?

7. Metal casting work involves melting metal and casting it into a mould. This includes manual or static casting processes such as those done in foundries and automatic processes such as injection, die or continuous casting. A typical process includes:

    - preparing a mould casting
    - melting and casting metal into the mould
    - removing and finishing the casting.

Who has duties?

8. **Employers** must provide and maintain, so far as is reasonably practicable, a working environment for their employees that is safe and without risks to health. **<OHS Act s21>** To ensure that employers provide a working environment that is safe and without risk to health, they must eliminate risks to health and safety so far as is reasonably practicable, and if it is not reasonably practicable to eliminate the risks to health and safety, reduce those risks so far as is reasonably practicable. **<OHS Act s20>**

> For information about what reasonably practicable means when complying with Part 3 of the OHS Act or OHS Regulations, see the WorkSafe Position – *How WorkSafe applies the law in relation to reasonably practicable* at worksafe.vic.gov.au.

9. Employers must, so far as is reasonably practicable, monitor conditions at the workplace under the employer's management and control. **<OHS Act s22(1)(b)>**

10. Employers must also, so far as is reasonably practicable, ensure that persons other than employees are not exposed to risks to their health or safety arising from the business activities undertaken by the employer. **<OHS Act s23 >**. An employer's duties under section 21 and section 35 of the OHS Act extend to independent contractors engaged by the employer and any employees of an independent contractor working at the workplace. However, these extended duties are limited to matters over which the employer has control or would have control if there was not an agreement in place purporting to limit or remove that control. **<OHS Act s21(3) and s35(2)>**

11. Regulations that set out the way an employer complies with their duties to employees under section 21 and section 35 of the OHS Act also apply in respect to independent contractors engaged by the employer and any employees of the independent contractor in relation to matters over which the employer has control. **<OHS Regulation r8(1)>**

12. Employers must also comply with additional duties prescribed in the OHS Regulations in relation to specific hazards such as hazardous substances, lead, crystalline silica, hazardous manual handling, plant, noise and falls. See Part 3 – Overview of foundry hazards.

13. A self-employed person must ensure, so far as is reasonably practicable, that persons are not exposed to risks to their health or safety arising from the business activities of the self-employed person. **<OHS Act s24 and OHS Regulations r11>**

14. Employees, while at work, must take reasonable care for their own health and safety and that of others who may be affected by their acts or omissions in the workplace. Employees must also co-operate with their employer's actions to make the workplace safe (for example by following any information, instruction or training provided). **<OHS Act s25(1)>**

The risk management process

15. This Code outlines a risk management process (see Diagram 1) to help employers comply with their duties under the OHS Act and OHS Regulations. It involves the following steps:

    - **identifying** hazards associated with metal casting work
    - **assessing**, where necessary, any associated risks

- **controlling** risks associated with metal casting work
- **monitoring, reviewing**, and where necessary, **revising** risk controls.

Diagram 1: The risk management process

16. For more information about the risk management process, see Part 2 – Overview of the risk management process.

Consultation

17. Employers must, so far as is reasonably practicable, consult with employees and HSRs, if any, on matters related to health or safety that directly affect, or are likely to directly affect them. This duty to consult also extends to independent contractors (including any employees of the independent contractor) engaged by the employer in relation to matters over which the employer has control. <OHS Act s35>

> **Note:** The characteristics of the workplace will have an impact on the way consultation is undertaken. For example, consider:
>
> - the size and structure of the business
> - the nature of the work
> - work arrangements (such as shift work)
> - characteristics of employees (such as language or literacy).
>
> Go to **worksafe.vic.gov.au** for more information on consultation.

18. An employer has a duty to consult with employees (including HSRs) and independent contractors when identifying or assessing hazards or risks to health or safety at the workplace, making decisions about measures to control such risks and proposing changes that may affect the health or safety of employees

at the workplace. <OHS Act s35>

19. It is important to consult with your employees as early as possible at each step of the risk management process, including when planning to:

    - introduce new work or change existing work
    - select new plant
    - refurbish, renovate or redesign existing workplaces
    - carry out work in new environments.

20. Employers who are required to consult on a matter must share information about the matter with employees, including relevant contractors and HSRs, give them a reasonable opportunity to express their views, and take those views into account before making a decision. If employees are represented by an HSR, the consultation must involve that HSR (with or without the involvement of the employees directly). If the employer and the employees have agreed to procedures for undertaking consultation, the consultation must be undertaken in accordance with those procedures. **<OHS Act s35>**

21. Employers also need to encourage employees and contractors to report any problems immediately so that risks can be managed before an injury occurs.

22. Employees and contractors may have practical suggestions or potential solutions that can be implemented.

Information, instruction, training and supervision

23. Employers must provide employees with the necessary information, instruction, training or supervision to enable them to perform their work in a way that is safe and without risks to health. This duty also extends to independent contractors (including any employees of the independent contractor) engaged by the employer in relation to matters over which the employer has control. **<OHS Act s21(2)(e)>**

24. The mix of information, instruction, training and supervision required will depend on the frequency and type of hazards in the workplace, and how much employees already know about the risks and necessary risk control measures.

25. Information, instruction and training needs to cover the nature of hazards associated with metal casting work, including the need for risk control measures and how to properly use them. For example, ensuring employees understand:

    - the nature of the hazards associated with metal casting work
    - the need for and proper use of measures to control risk
    - the selection, use, fit, testing and storage of any personal protective equipment (PPE).

26. Employers must provide supervision to employees where such supervision is necessary for safe work. <**OHS Act s21(2)(e)>** This is particularly important with employees who are more vulnerable in their work areas, such as new, inexperienced or young employees.

27. Employers need to ensure that supervisors take action to enable employees to perform their work in a way that is safe and without risks to health. This should include correcting any unsafe work practices as soon as possible.

28. Where the employees undertaking the work are new and inexperienced, such as apprentices or young employees, it is often necessary to provide additional supervision.

29. Training programs should be practical and 'hands on'. The structure, content and delivery of the training needs to take into account any special requirements of the employees and independent contractors being trained (eg specific skills or experience, disability, language, literacy and age).

30. Employers need to review their training programs regularly and also when:

    - there is change to work processes, plant or equipment
    - there is an incident
    - new control measures are implemented

- there is a request by an HSR
- changes are made to relevant legislation, or
- any other issues impact on the way the work is performed.

Employers should also keep records of induction and training given to employees.

31. Refresher training needs to be provided as appropriate for a particular workplace. The frequency of refresher training should be determined having regard to the frequency with which employees and independent contractors are required to carry out tasks associated with metal casting.

Part 2 - Overview of the risk management process

Identifying hazards

32. The first step in the risk management process is to identify the hazards associated with metal casting work. Hazards may arise due to the nature of the work itself, or from the raw materials being used in the work or by-products generated during the process.

33. Examples of hazards arising from the nature of metal casting work itself include:

- working near furnaces and hot metal
- steam explosions
- noise and vibration from plant
- hazardous manual handling of cast metal
- movement of powered mobile plant such as forklifts.

34. Examples of hazards arising from raw materials being used in the work include:

- fumes from molten metal and additives such as lead
- dust containing respirable crystalline silica generated from sand
- flammable substances such as solvents
- toxic substances such as formaldehyde.

Assessing the risks

35. A formal risk assessment may not be necessary if knowledge and understanding about the risk and how to control it already exist. For example, an employer who knows there is a risk of employee exposure to respirable crystalline silica from handling dry sand, and knows the risk can be eliminated by using olivine sand, can put the control in place immediately. However, if employers are unsure about how to control a risk, a risk assessment can help. Note prior to introducing a new product or process the hazards associated with the new product or process need to be assessed to determine the risks and required controls and whether the new product or process is a safer alternative.

Controlling the risks

36. Employers must control any risks to health or safety associated with metal casting work, so far as is reasonably practicable, as part of providing a healthy and safe working environment. **<OHS Act s21>**

37. When considering risk control options, employers need to consider relevant information about the nature of the work to be performed and how this may create a risk to health or safety. Employers also need to consider whether a risk control measure will introduce additional risks.

38. Employers must consult with their employees (including any HSRs) when making decisions about how to control risks. **<OHS Act s35>** Consulting with employees is likely to result in better risk control measures because it gives them the opportunity to contribute ideas and is likely to improve the uptake of risk control measures when they are implemented.

Hierarchy of control

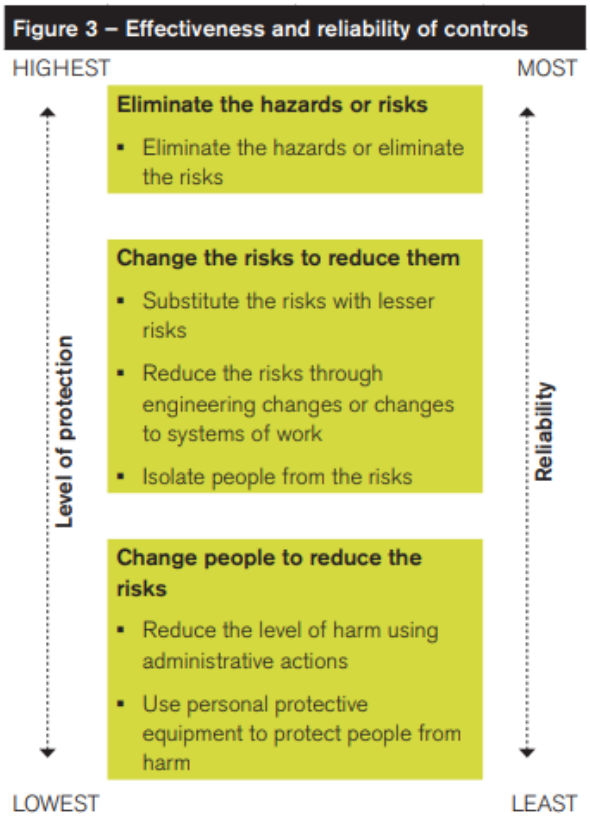
39. The OHS Regulations set out a specific order in which to apply controls (called a hierarchy of control) for particular hazards. Hazards with specified hierarchies of control include:

- asbestos
- confined spaces
- crystalline silica
- falls from heights
- hazardous substances

- hazardous manual handling
- lead
- noise
- plant.

For information about applying the hierarchies of control for these hazards, go to **worksafe.vic.gov.au**. See also Part 3 – Overview of metal casting hazards.

40.



Maintaining risk controls

41. A person who is required by the OHS Regulations to use any particular measure to control risk must ensure that the measure is properly installed (if applicable), used and maintained. **<OHS Regulations r18>**

Review and revision of risk controls

42. It is important to monitor risk controls to ensure they remain effective. The OHS Regulations set out requirements for when risk control measures must be reviewed and if necessary revised for specific hazards. See the relevant compliance code for more information.

Part 3 – Overview of foundry hazards

Molten metal explosions

Steam explosions

43. Steam explosions are caused by introducing moisture into molten metal or by pouring molten metal onto materials containing moisture. Sources of moisture include:

    - containers that hold liquids (eg drink cans, aerosols or mobile phone batteries)
    - scrap that is damp or contaminated (eg with water)
    - ingots or returns with dampness in shrinkage cavities
    - moisture in fluxes
    - heavily oxidised or rusted materials, or rust on the surface of tools or equipment
    - damp refractories or tools.

44. Employers need to identify the potential sources of moisture that could come into contact with molten metal, and eliminate or control these risks. Controls include:

    - not allowing bottles and containers that hold liquid, or sealed or pressurised cans in molten metal areas. If these items are needed for maintenance or work purposes, employers should control their storage, use and disposal.
    - ensuring deliveries of materials are free of moisture and rust
    - storing materials in an appropriate dry area, for example a covered area where materials are not exposed to rain
    - preheating furnaces and refractories before use
    - ensuring all equipment and tools are free of rust and are preheated before use
    - ensuring charges are dry and free from any entrapped moisture before adding to the melt

Chemical explosions

45. Chemical explosions can occur if certain reactive or flammable chemical substances are added by mistake to molten metal, causing gas pressure to build up. Chemical explosions can also occur by incorrectly mixing incompatible combinations of chemicals such as resins (eg. phenol-formaldehyde, furan) and catalysts (eg. strong acids) during the mould-making process. Explosions may also occur if a reactive substance is a contaminant in charge material.

46. To control the risks, employers should 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 away from ignition sources and incompatible chemicals
    - all 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 illness

47. Working in hot conditions is hazardous. Health effects can range from mild to life threatening, and include:

    - discomfort
    - heat rash
    - heat cramps

- heat exhaustion
- heat stroke, which is a medical emergency that can result in permanent damage or death.

48. Heat illness occurs when the body cannot maintain a healthy temperature. An employee may not be aware that they are affected by heat illness until it is almost too late. Heat illness can affect concentration, perception and decision-making, so a person's behaviour and consciousness may be impacted.

49. In addition to furnace heat, the following factors can contribute to heat illness:

- job factors such as strenuous work, sustained exertion and inadequate recovery time
- seasonal factors such as high air temperature and relative humidity or low air movement
- excessive or inappropriate clothing or PPE
- fatigue
- existing health conditions.

50. Employees who work in hot environments can acclimatise to the heat over time. Acclimatising can reduce discomfort, increase sweating effectiveness, reduce salt loss and return recovery rate to normal. As it takes time, acclimatisation is lost when employees are away from the environment – for example, if they go on leave. Employees who have been away for a week or more should be given time to reacclimatise. Acclimatisation only provides a small amount of protection. While acclimatised employees are at less risk than unacclimatised, they are still at risk.

51. To control the risks, employers should ensure that:

- tasks are automated where reasonably practicable
- unnecessary heat and water vapour sources are eliminated
- radiant emissions from plant and other hot surfaces are shielded
- spot coolers, blowers, fans or air conditioning relieve heat and humidity and move the air
- de-humidifiers and other humidity reduction methods are used
- ventilation such as flues draw cooler air in
- clean fresh water is supplied
- employees have access to a respite area such as a cool room or heat refuge
- frequent breaks

52. Employers should ensure that a policy and associated procedures on heat illness are developed and that employees are fully trained in the requirements. The policy should include:

- an acclimatisation process
- a 'buddy system' where each employee 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 employees
- rotation of hot tasks between employees to minimise exposure time
- a provision that employees are trained and given information about heat effects, and are continuously monitored for signs (symptoms) of heat illness
- contingency and treatment for affected employees including those employees with existing health conditions.

53. In addition to other control measures, employers should ensure that task-specific PPE (eg water cooled or heat reflective clothing) is provided.

54. Where there is uncertainty as to whether circumstances may be a heat illness situation that requires additional controls a heat illness risk assessment should be undertaken.

Hot surfaces, radiation and splashes

55. Burns are one of the most serious types of injuries that may occur in molten metal casting. They are generally caused by contact with hot surfaces, heat radiation or molten metal splashing.

56. To control the risks, employers should ensure that:

- automated machinery is used, so far as is reasonably practicable, to reduce risks associated with handling of casting moulds and other hot surfaces or liquids
- employees not directly involved in casting operations are separated from the casting area
- cooling castings are physically separated from where employees are working and castings should be assumed to be hot (as they can appear cool but still be very hot)
- 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 43)
- only dry PPE is used when working with molten or hot metal.

Light radiation

57. 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.

58. To control light radiation risks, employers should 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

59. Employees may be exposed to a range of hazardous substances used in metal casting processes, and also substances generated by these processes. See appendix X for examples of hazardous substances that may be used in or generated by metal casting operations.

60. Hazardous substances may be inhaled, ingested 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. Always refer to the Safety Data Sheet (SDS) before using a chemical for the first time to find information on the health hazards and routes of exposure of the chemical as well as the controls required when using it.

61. Hazardous substances used in metal casting work include:

- cleaning chemicals
- binding agents used in moulds
- agents painted onto moulds or sprayed onto dies to release castings
- ingredients added to molten metal
- gases in cylinders.

62. Hazardous substances generated by metal casting operations include:

- respirable crystalline silica from sand and refractories (see page x)
- fumes from heated or molten metals
- fumes from binding agents, resins and catalysts used in sand moulds and cores

- gases (eg sulphur dioxide, ozone, carbon monoxide) from metal charging and melting processes
- metal dust from cleaning, finishing and handling materials.
- wood dust from pattern making.

63. Some metal fumes may cause respiratory and/or skin sensitisation or cancer. Metal fume fever, an acute allergic condition, results from exposure to beryllium, zinc, copper, 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.

64. Some gases such as carbon monoxide have no odour and may not be detected until their irritating effects such as respiratory difficulty, coughing, asthma and eye watering are detected. Gases such as carbon monoxide can also displace oxygen resulting in asphyxiation when stored and handled in confined spaces or small spaces with no ventilation.

65. Uncontrolled charging and melting processes can also 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.

66. Metal casting operators should consult with Environment Protection Authority (EPA) Victoria on the release of contaminants into the environment (eg air, land, noise, water).

67. Employers have a number of duties under Part 4.1 (Hazardous substances) of the OHS Regulations to manage the risks associated with hazardous substances in the workplace. These include, but are not limited to:

    - obtaining the current version of a safety data sheet (SDS) for a hazardous substance used in their workplace on or before the first time the hazardous substance is supplied to the premises **<OHS Regulations r155>**
    - ensuring a current SDS is readily accessible to any employee who may be exposed to the substance **<OHS Regulations r156>**
    - ensuring a container in which a hazardous substance is supplied to their workplace is labelled with the manufacturer's or importing supplier's label **<OHS Regulations r158>** and remains labelled until it has been cleaned or its contents neutralised, cured or chemically deactivated to the extent that it is not a risk to health **<OHS Regulations r159>**
    - ensuring a register of all hazardous substances supplied to the workplace is prepared and maintained and includes a copy of the SDS for each substance **<OHS Regulations r162>**
    - eliminating any risk associated with hazardous substances at the workplace, so far as is reasonably practicable, and if the risk cannot be eliminated, reducing the risk, so far as is reasonably practicable, according to the hierarchy of control set out in **<OHS Regulations r163>**
    - ensuring an employee's exposure to a hazardous substance does not exceed the exposure standard (if any) for that substance or any of its ingredients **<OHS Regulations r165>**
    - ensuring atmospheric monitoring **<OHS Regulations r166>** and health monitoring is carried out if required **<OHS Regulations r169**>.

68. For information about complying with your duties in relation to hazardous substances, see the *Hazardous substances compliance code*.

> **What is an exposure standard?**
> An exposure standard is a maximum airborne concentration of a substance that a person may be exposed to in their breathing zone, averaged over an 8 hour work day and 40 hour work week.
> For the purposes of the OHS Regulations, exposure standard means an exposure standard set out in the Workplace Exposure Standards for Airborne Contaminants published by Safe Work Australia. **<OHS Regulations r5>**

Table 1 Applying the hazardous substances hierarchy of control in metal casting operations

(OHS Regulations r163)

Level		Example
1 Eliminate any risk associated with hazardous substances		Eliminate the use of the hazardous substance, for example not use asbestos-containing seals/materials
2 Reduce the risk associated with hazardous substance with one or more of:	**Substitution**	Substitute the substance with something less hazardous, or the same substance in a less hazardous form, for example, use a detergent in place of a chlorinated solvent for cleaning or use a less toxic mould release agent.
	Isolation	Isolate people from exposure to the substance (for example use screens and barriers around pouring areas or automated/remote charging to isolate personnel from potential fume generating processes)
	Engineering controls	Use engineering controls to reduce the generation of substances, such as extractive hoods or canopies above furnaces to capture fumes.
3 Reduce the risk associated with a hazardous substance using administrative controls		Implement systems of work that help to reduce exposure to hazardous substances, such as restricting employee access to process areas, job rotation and preventing eating, drinking and smoking in work areas.
4 Reduce the risk associated with a hazardous substance by providing PPE equipment		Task-specific protective equipment and clothing, for example using respiratory protective equipment (RPE) when pouring a liquid chemical. [see Part 5 (page 41)]

Lead

69. Lead is a naturally occurring metal, which can combine with other substances to form various lead alloys and compounds. It is used as an alloying agent and may be present in recycled scrap being used.

70. Lead is a health risk when it is taken into the body. Lead can be inhaled through dust, fumes or mist. It can also be swallowed, when your hands come into contact with lead and then you eat, drink or smoke. Symptoms of lead exposure include headaches, tiredness, irritability, nausea, stomach pains and anaemia. Continued exposure can lead to kidney, nerve and brain damage, lead palsy and death.

Lead processes

71. Regulation 178 of the OHS Regulations defines specific activities that expose a person to lead dust or fumes as 'lead processes'. This includes metal-casting processes involving:

    - the melting or casting of lead alloys containing more than 1% by weight of lead metal in which the temperature of the molten material exceeds 450ºC, or
    - the dry machine grinding, discing, buffing or cutting by power tools of lead alloys containing more than 1% by weight of lead metal

72. Employers have specific duties under Part 4.3 (Lead) of the OHS Regulations in all workplaces where lead processes are undertaken. These include, but are not limited to:

    - providing certain information to job applicants **<OHS Regulations r182>**, and certain information to employees before they start work on a lead process **<OHS Regulations r183>**
    - eliminating any risk associated with exposure to lead so far as is reasonably practicable, and if the risk cannot be eliminated, reducing the risk, so far as is reasonably practicable, according to

the hierarchy of control set out in **<OHS Regulations r184>**

- ensuring employees are not exposed to an airborne concentration of lead dust, mist or fumes above the exposure standard and conducting air monitoring in certain circumstances **<OHS Regulations r186-7>**
- containment of lead contamination **<OHS Regulations r188>** and cleaning of lead process areas **<OHS Regulations r189>**
- ensuring the prohibition of eating, drinking and smoking in an area where a lead process is undertaken **<OHS Regulations r190>**
- providing changing and washing facilities **<OHS Regulations r191>**, and for laundering of protective and work clothing **<OHS Regulations r192>**.

73. For information about complying with your duties in relation to lead, go to **worksafe.vic.gov.au.**

Table 2 Applying the lead hierarchy of control in metal casting operations

(OHS Regulations r184)

Level		Example
1 Eliminate any risk associated with exposure to lead		
2 Reduce the risk associated with exposure to lead with one or more of:	**Substitution**	
	Isolation	Isolating employees from areas where lead fumes are being produced. Restricting employee access to lead process areas**.**
	Engineering controls	Extractor hoods above furnaces. Dust extraction systems for buffing discing, grinding or cutting of castings containing lead For lead-melting operations, automatic thermocouple control systems to manage the melting process.
3 Reduce the risk associated with a exposure to lead using administrative controls		Confining processes involving lead to designated areas and sign posting them Rotating employees through a lead process to reduce exposure time. Preventing dry sweeping. Implementing work practices and equipment that produce a minimum of residue. Ensuring lead process areas are kept clean and that cleaning does not increase the risk for others or spread contamination. Provide clean facilities: a washroom, shower, storage for clean and contaminated work clothing.

4 Reduce the risk associated with exposure to lead by providing PPE equipment	Task-specific protective clothing and equipment. [see Part 5 (page 41)]

Crystalline silica

74. Crystalline silica is a naturally occurring mineral. The most common type of crystalline silica is quartz, which is contained in sand, a material commonly used in foundries. Sand can contain up to 100% crystalline silica.

75. Some dust particles of crystalline silica, known as respirable crystalline silica (RCS), are so small they cannot be seen with the naked eye. RCS can be harmful when it becomes airborne and is inhaled. Exposure to high airborne concentrations over a short period of time, or low to medium airborne concentrations over a long period of time can lead to serious diseases, including:

    - silicosis
    - lung cancer
    - kidney disease
    - autoimmune disease.

76. Silicosis is a serious, incurable, irreversible and progressive disease. It occurs with the body's immune response to the presence of crystalline silica dust in the small airways and tiny air sacs (alveoli) of the lungs, and results in scarring the lung tissue. In the early stages there may not be any warning symptoms, but as the disease progresses symptoms such as shortness of breath, coughing, fatigue and weight loss can develop. In severe cases, the damage to the lungs caused by silicosis can require a lung transplant or may lead to death.

77. Dust containing RCS is generated by processes such as:

    - mould and core making
    - cast cleaning
    - abrasive blasting and rumbling
    - furnace maintenance/relining/patching
    - sand preparation and reclamation.

78. Employers have a number of duties under Part 4.1 (Hazardous substances) of the OHS Regulations to manage risks associated with exposure to crystalline silica in the workplace. These duties include but are not limited to:

    - eliminating any risk associated with exposure to crystalline silica, so far as is reasonably practicable, and if the risk cannot be eliminated, reducing the risk, so far as is reasonably practicable, according to the hierarchy of control set out in **<OHS Regulations r163>**
    - ensuring that employees are not exposed to an atmospheric concentration of crystalline silica dust generated at the workplace above the relevant exposure standard **<OHS Regulations r165>**
    - ensuring that atmospheric monitoring **<OHS Regulations r166>** and health monitoring is carried out when required. **<OHS Regulations r169>**

79. In addition, Part 4.5 (Crystalline silica) of the OHS Regulations defines specific activities that expose a person to RCS as 'crystalline silica processes', for example, using a power tool or other form of mechanical plant to carry out any activity involving material containing crystalline silica that generates crystalline silica dust. **<OHS Regulations r319C>**

80. Employers and self-employed persons must conduct a risk assessment to identify whether a crystalline silica process is high risk silica work. **<OHS Regulations r319P>** High risk silica work is work performed in connection with a crystalline silica process that is reasonably likely to result in:

    - an airborne concentration of RCS that exceeds half the exposure standard

- a risk to the health of a person in the workplace **<OHS Regulations r319D>**

81. For high risk silica work, employers and self-employed persons must ensure a crystalline silica hazard control statement is prepared and work is carried out in accordance with it.

82. For information about complying with your duties in relation to crystalline silica, see the *Hazardous substances compliance code*.

Table 3 Applying the hazardous substances hierarchy of control for crystalline silica exposure in metal casting operations

(OHS Regulations r163)

Level		Example
1 Eliminate any risk associated with hazardous substances		Use products that do not contain crystalline silica, such as chromite or olivine sand.
2 Reduce the risk associated with hazardous substance with one or more of:	**Substitution**	Use products with a lower silica content
	Isolation	Ensuring 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)
	Engineering controls	Addition of binders to sand. Sand delivery processes that reduce the amount of loose sand and effectively control potential generation of airborne particulate. Local exhaust ventilation (LEV) over areas where mechanical handling or preparation is likely to generate airborne dust On-tool extraction on grinding, polishing and linishing machines. Ventilation positioned to draw dust away from employees rather than through their breathing zone. Down-draught tables and grilles large enough to allow cleaning to be conducted within the boundaries of the down-draught.
3 Reduce the risk associated with a hazardous substance using administrative controls		Ensuring ventilation systems are regularly examined to ensure they are safe and functioning correctly, and defective and/or unsafe ventilation systems are repaired immediately. Implementing a clean as you go policy. Prohibiting the use of compressed air for area and personal cleaning.
4 Reduce the risk associated with a hazardous substance by providing PPE equipment		Task-specific protective equipment and clothing (RPE may be required**)** [see Part 5 (page 41)]

83. The OHS Regulations prohibit the use of abrasives containing more than one per cent of crystalline silica

for abrasive blasting. <**OHS Regulations r153, Schedule 6**>

Industrial waste

84. Industrial waste must be transported, stored and disposed of in accordance with Victorian environment protection law and EPA requirements. Where no legislative controls apply, a safe means of transport and disposal for hazardous waste (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). For more information about managing hazardous waste, go to https://www.epa.vic.gov.au/

85. To control the risks, employers should ensure that:

- hazardous waste is clearly identified and sealed in suitable containers
- containers are secured against damage, and stored and handled correctly
- task-specific PPE is worn by employees in the workplace (**see page** 42).

Dangerous goods

86. Dangerous goods in metal casting operations include:

- binders and catalysts used in mould and core making
- solvents in core washing
- additives used in the melt (eg for degassing)
- products and by-products of the melting process such as aluminium liquid
- gases in cylinders.

87. Dangerous goods may be highly flammable, explosive, corrosive, acutely toxic, asphyxiant or highly reactive, according to their class. They are readily identifiable by class diamonds on the labels. See Appendix X for a list of dangerous goods commonly used in metal casting, their classes and hazards.

88. One of the biggest hazards in molten metal workplaces is the potential for dangerous goods to be incorrectly marked, mixed with commonly used 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.

89. Under the *Dangerous Goods Act 1985* and the Dangerous Goods (Storage and Handling) Regulations 2012, occupiers of premises where dangerous goods are stored and handled have duties to manage risks associated with dangerous goods in the workplace. These include:

- ensuring dangerous goods are labelled correctly
- keeping a register of all dangerous goods stored and handled in the workplace
- obtaining the SDS for the dangerous goods stored or handled at the premises
- ensuring all people who use dangerous goods are provided with information, trained and supervised
- identifying hazards associated with the storage and handling of dangerous goods at the premises and ensuring they are eliminated or reduced
- ensuring incompatible chemicals are stored well apart, so far as is reasonably practicable
- ensuring placards used as required for storage and handling of specified quantities of dangerous goods.

For more information, see the Code of practice for the storage and handling of dangerous goods.

90. Many of the hazardous substances that are included in the OHS Regulations are also classified as dangerous goods, and in these cases both sets of legislation apply.

Slips, trips and falls

91. Slips, trips and falls are particularly hazardous in metal casting workplaces. Consequences of slips, trips and falls can range from mild (such as scrapes) to severe (such as burns, fractures or fatalities). Molten metal spills present particularly serious slip and fall risks (see paragraph x).

92. To control the risks of slips, trips and falls, employers should ensure that:

- trip hazards such as hoses, cords and rubbish are eliminated
- the workplace layout is designed around workflow
- floors are level, slip resistant, firm, durable, and do not accumulate water
- floor surface material resists damage from the metal casting process (eg 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
- employees wear task-specific protective clothing.

Hazardous manual handling

93. Hazardous manual handling tasks occur during pattern and core making, loading furnaces, moulding, fettling, dispatch, inspection and surface coating.

> Hazardous manual handling means work requiring the use of force exerted by a person to lift, lower, push, pull, carry or otherwise move, hold or restrain –
>
> - a thing if the work involves one or more of the following –
> - repetitive or sustained application of force
> - sustained awkward posture
> - repetitive movement
> - application of high force involving a single or repetitive use of force that it would be reasonable to expect that a person in the workforce may have difficulty undertaking
> - exposure to sustained vibration
> - live persons or animals
> - unstable or unbalanced loads or loads that are difficult to grasp or hold. **<OHS Regulations r5>**

94. Employers have a number of duties under Part 3.1 (Hazardous manual handling) of the OHS Regulations to manage risks associated with hazardous manual handling in the workplace. These duties include but are not limited to:

- identifying, so far as is reasonably practicable, any work (current or proposed) that involves hazardous manual handling **<OHS Regulations r26>**
- eliminating, so far as is reasonably practicable, any risk of a musculoskeletal disorder (MSD) associated with hazardous manual handling **<OHS Regulations r27>,** or where this is not reasonably practicable, reducing the risk so far as is reasonably practicable by using the hierarchy of control in **<OHS Regulations 27>**
- reviewing, and if necessary revising, risk control measures **<OHS Regulations 28>**

95. In metal casting work, the risks of MSDs can be increased by working in a hot environment, which can make gripping and handling things more difficult. Employees may have trouble grasping things or there may be unexpected forces from loads slipping. Hot objects (such as castings) will be more difficult to handle and can lead to awkward postures.

Vibration

96. Employees may be exposed to sustained (more than 30 seconds) whole-body vibration during tasks such as pneumatic ramming operations, when using finishing tools, shake out/knock out, sand-slinging, and operating forklifts or cranes. 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.

97. Exposure to sustained hand-arm vibration can occur when using 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.

98. 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.

99. Where there is uncertainty about the risk, a risk assessment should be undertaken. For example, instruments (accelerometers) can be used to measure/monitor employee exposure to vibration levels when using a tool and determine the level of risk.

100. For information about complying with your duties in relation to hazardous manual handling, see the *Hazardous manual handling compliance code*.

Table 4 Applying the hazardous manual handling hierarchy of control in metal casting operations

(OHS Regulations r27)

Level of control	Control measures
1. Eliminate the risk of MSD	Eliminate the hazardous manual handling task where possible by providing equipment (eg use overhead cranes for moving materials, use remote control jackhammers for furnace maintenance/relining)
2. Reduce the risk of MSD by changing: • **workplace layout** • **work environment** • **systems of work** • **things used** • **mechanical aids** • **any combination of the above.**	Designing the work layout to make the task less hazardous (eg carrying items less distance or using conveyors). Alter the work environment to reduce heat or vibration (eg moving tasks away from furnaces) Systems of work (eg rotating tasks to avoid repetitive movements) Change the tools used (eg select hand held tools that reduce vibration) Use mechanical aids where possible (eg trolleys, tool supports, forklifts). Use gloves to increase grip force
3. Reduce the risk of MSD by providing information, instruction or training.	Provide employees with information, instruction or training on how to reduce the risk of MSD (eg provide training on safe ways to handle hot objects).

Plant (machinery and equipment)

101. Plant used in metal casting workplaces includes:

- cranes, hoists, forklifts and conveyors used as mechanical handling devices
- machinery and equipment used in pattern and core making
- die casting plant
- furnaces and other machinery used in casting and moulding
- spectrographs and other testing equipment
- portable and fixed tools for finishing.

102. There are three kinds of hazards associated with plant:

- **Mechanical hazards:** due to moving parts, ejected objects and equipment that may be operated in areas of pedestrian activity (such as a forklift). Mechanical hazards include hard surfaces coming together and scissoring action. Risks include entanglement, crushing, severing, cutting and slips, trips and falls.
- **Non-mechanical hazards:** such as airborne contaminants, explosive atmospheres, heat, radiation, chemicals, vibration, electricity and noise.
- **Access hazards:** including confined spaces, falls, and hazardous manual handling.

103. Employers have duties under the OHS Act to provide or maintain plant that is, so far as reasonably practicable, safe and without risks to health. **<OHS Act s21(2)(a)>** In addition, Part 3.5 (Plant) of the OHS Regulations sets out requirements for employers and self-employed persons, in relation to specific types of plant. These include but are not limited to:

- identifying, so far as is reasonably practicable, all hazards associated with the installation, erection, commissioning, decommissioning, dismantling and use of plant at the workplace where it is used and the systems of work associated with the plant **<OHS Regulations r97>**
- eliminating any risk associated with the plant, so far as reasonably practicable **<OHS Regulations r98(1)>** and where a risk cannot be eliminated, using the hierarchy of control to reduce the risks so far as is reasonably practicable. **<OHS Regulations r98(2)>**

104. Employers should carry out routine inspection and maintenance for all machinery and equipment to ensure it remains in a safe working condition. The adverse environmental conditions in metal casting workplaces (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.

105. For information about complying with your duties in relation to plant, see the *Plant compliance code*.

Table 5 Applying the plant hierarchy of control in metal casting operations

(OHS Regulations r98)

Level		**Example**
1 Eliminate any risk associated with plant		Use automated processes such as fettling robots and computer numerical control (CNC) grinding machines
2 Reduce the risk associated with plant with one or more of:	**Substitution**	Substitute finishing equipment for noise-reduced equipment.
	Isolation	Separating employees from machinery and equipment by barriers (eg interlocked guards), distance (eg enclosures), or time (eg when machine is disabled).

	Engineering controls	Automatic systems such as two-handed operation, presence sensors or fail-safe controls.
3 Reduce the risk associated with plant using administrative controls		A system of regular inspection to ensure plant is safe and functioning correctly and maintained to manufacturer's specifications.
4 Reduce the risk associated with plant by providing PPE equipment		Task-specific protective clothing and equipment. [see Part 5 (page 41)]

Electricity

106. 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.

107. 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.

108. To control the risks, employers need to ensure that:

- sources of electrical risk are identified and controlled by elimination or isolation including interlocking of guarding
- energy sources are isolated, locked out, tagged out and de-energised before machinery maintenance commences
- electrical equipment condition is checked before use
- 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
- 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.

Noise

109. A range of metal casting equipment and processes may generate noise above the noise exposure standard, including:

- pattern and core making
- moulding
- die casting plant
- knockout and cleaning operations
- finishing processes such as rumbling, grinding and shot blasting
- some furnaces.

Noise exposure standard means noise levels set by the OHS Regulations as the 8-hour equivalent continuous sound pressure of 85 decibels (A) measured in A-weighted decibels referenced to 20 micropascals at an employee's ear position, or a C-weighted peak hold sound pressure level reading of 140 decibels (C) measured in decibels referenced to 20 micropascals at an employee's ear position. **<OHS Regulations r5>**

Table 6 dB(A) levels of metal casting equipment

Equipment	Level (dB(A))
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

110. Exposure to excessive noise can cause temporary hearing loss and tinnitus. Repeated exposure over a period of time can cause noise-induced hearing loss, which cannot be repaired.

111. Employers have a number of duties under Part 3 (Noise) of the OHS Regulations to manage risks associated with noise exposure in the workplace. These include but are not limited to:

- ensuring employees are not exposed to noise exceeding the noise exposure standard by **<OHS Regulations r34>**
- eliminating, so far as is reasonably practicable the source of noise to which an employee is exposed, and if it is not reasonably practicable to eliminate the source of noise reduce employee exposure to the noise so far as is reasonably practicable by applying the hierarchy of control in **<OHS Regulations r34>**
- ensuring employees are provided with audiometric testing (hearing tests) where hearing protection is required to control an employee's noise exposures to below the exposure standard, and in some cases audiological examinations **<OHS Regulations r37-40>**
- providing employees with hearing protectors, and where hearing protection is provided, ensuring that appropriate signage, labelling of plant or other appropriate means are used to identify when and where the hearing protectors are to be worn are in the workplace.**<OHS Regulations r34-35>**

112. For information about complying with your duties in relation to noise, see the *Noise compliance code*.

Table 7 Applying the noise hierarchy of control in metal casting operations

(OHS Regulations r34)

Level of control		Examples of control measures
1 Elimination		Ceasing the use of a noisy machine
2 Reducing employee exposure to noise by:	**Substitution**	Substituting a quieter machine. Use of better moulds to reduce the amount of grinding/finishing required. Using a remote controlled jackhammer rather than a manual jackhammer
	Engineering controls	Soundproof enclosures or noise barriers for noisy tasks

3 Administrative controls	Providing quiet rest areas.
4 PPE	Task-specific hearing protection. [see Part 5 (page 41)]

Access and confined spaces

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

114. Employers have specific obligations in relation to working at height under Part 3.2 (Prevention of falls) of the OHS Regulations. For more information see the *Prevention of falls in general construction* compliance code.

115. Employers have specific obligations in relation to confined spaces under Part 3.4 (Confined spaces) of the OHS Regulations. For more information see the *Confined spaces* compliance code.

Part 4 - Metal casting processes

116. This Part describes the main hazards associated with specific tasks in the metal casting process and key recommended risk controls for those tasks. These should be read alongside the general information about controlling risks in Part 3. Not all hazards/risks are covered in this Part. Employers should undertake hazard identification and risk assessment (as outlined in Part 2).

Workplace design and general processes

Building setup

117. Employers should 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 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
- the floor surface is made from refractory brick in metal melting areas (concrete can spall and explode when in contact with molten metal, due to trapped moisture)
- 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
- 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.

118. Open pits, deep moulds and other floor openings need to be 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.

119. 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

120. 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

121. 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.

Workplace layout and work flow

122. Workplace layout and workflow design needs to take into account the hazards associated with molten metal and other processes. When planning workflow, employers should ensure that:

- sand processes are segregated from other plant operations and are enclosed as much as possible
- furnace areas are kept clear and unrestricted
- employees do not work under suspended objects such as castings, moulding boxes or ladles
- traffic is directed away from hot areas and hot cast metal
- amenities are located away from areas exposed to heat, dust, noise or fumes.

123. Employers should ensure that processes not directly related to furnace work are not conducted near furnaces. For example secondary processes such as cleaning or rattling finished products 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 should ensure employees are protected by barriers and protective clothing (see page 42)

124. Employers should ensure that quarantine procedures are enforced for entry to the metal casting area. The following types of items should be quarantined due to the hazards they pose when exposed to extreme heat, molten metal, radiation or for personal hygiene reasons:

- mobile phones and other battery-operated devices
- liquid fuels such as cigarette lighters
- food and food containers, especially open drink containers (food and drink should 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.

125. Employers also should ensure that:

- the work area is kept clear of rubbish and hoses, and cords do not cross the floor
- leaking or dripping water pipes or fittings are repaired immediately
- aisles are kept open and clear
- items that are not being used are stored safely in non-working areas.

126. Hazardous substances and dangerous goods need to be stored safely to reduce unnecessary exposure 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.

127. Safety checks should be developed for both standard work and emergency procedures, tested regularly.

Emergency and first aid arrangements

128. 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.

129. Safety showers and eyewash stations need to be easily accessible on an unobstructed path at the same level and near the hazard. Ideally, they would be accessible within 10 seconds, but molten metal operations 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 need to be tested regularly.

130. Emergency procedures, such as first aid and fire drills, should take place at appropriate intervals consistent with the risks at site.

131. For more information about first aid provision, see *the First aid in the workplace compliance code*.

Workplace facilities

132. Employers must provide, so far as is reasonably practicable, adequate facilities for the welfare of employees at any workplace under the management and control of the employer. **<OHS Act s21(2)(d)>** Facilities include toilets, shelters, seating, dining areas, change rooms, drinking water, personal storage and washing facilities. For more information, see the *Workplace amenities and work environment compliance code*.

Receiving raw materials

Sand

133. Handling dry sand can expose employees to RCS (see paragraphs 75-84).

134. Pneumatic sand conveying systems can reduce RCS exposure during storage and handling of sand.

135. Employers should conduct a risk assessment and, in determining whether proposed controls will be effective, take into account:

- air volume and pressure
- quantity of sand
- layout
- receiving bins and dust collector
- whether it is a fully enclosed system or operators are required to perform tasks such as emptying the dust collector system (thereby creating potential for exposure)

136. To control risks, employers should ensure that:

- access to sand receiving areas is restricted
- if possible, sand plant is segregated from other areas
- extraction and filtering systems are inspected and maintained regularly
- employees wear RPE when required, for example where the system is not fully enclosed

Metal and other materials to be used in the melt

137. Material containing contaminants may trigger a violent reaction when added to molten metal (see paragraph 43). A thorough visual inspection of all materials and packaging before charging will ensure materials are clean, dry and free of corrosion.

138. Any materials that will be charged into molten metal need to be 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)

139. Contaminated material needs to be quarantined until it has been cleaned. If there is heavy contamination or if the source of the contamination cannot be identified, the material should be returned to the supplier.

140. Hollow objects such as tubes or pipes can contain moisture. Add these items as the primary charge or return to the supplier.

141. Where possible, porous charge or scrap that may contain moisture should be added to the furnace as the primary charge.

Design and pattern making

142. Computer aided product design and production modelling should be used as it can help reduce the likelihood of problems in pouring and other processes, and eliminate defects in the mould or the product.

143. Pattern making involves making a replica of the object that is to be cast, out of wood or other material. The main hazards associated with this process are:

- reinforced plastic resins, epoxy resins and adhesives (skin and respiratory problems)

- catalysts used in urethane systems such as formaldehyde, isocyanates and mould-release paints (respiratory sensitisation)
- wood dust
- noise from woodworking and metal machining
- fire/explosion from patterns and dust – controlled and uncontrolled
- falling objects from storage and movement of patterns
- hazardous manual handling of heavy and awkward items, and sustained awkward postures
- plant – machinery, cranes and forklift
- electricity
- falls from heights during pattern retrieval and storage.

144. Risk control measures include:

- hazardous manual handling risk assessments
- racking and shelving appropriate to the contents
- training and certification
- dust extraction equipment
- employees wear PPE, for example respirators etc for fumes from catalysts.

Mould and core making

Sand moulds and cores

145. Making a sand mould usually involves mixing sand with chemical binders in a mixer, then dispensing into a mould box and packing the sand. Once set, the mould may be painted with refractory paint.

146. A core is used to create a hollow interior in a casting. The core is made of sand mixed with chemical binders, moulded either manually or by machine. It may then be cured and coated with refractory paint.

147. Hazards associated with making sand moulds and cores include:

- direct skin exposure to hazardous substances, for example amines, esters, solvents, isocyanates, toluene, phenol, formaldehyde, furfuryl alcohol
- inhalation of atmospheric contaminants from the volatile mould binders, catalysts (sulphur dioxide, amines, acids), RCS, carbon monoxide, ammonia
- compressed air
- noise
- hazardous manual handling of heavy and awkward items (eg cores and mould boxes)
- awkward postures and repeated vibrations associated with ramming moulds
- slips, trips and falls including from sand and poor housekeeping
- radiation from zircon sand
- fire and explosion from flammable gases and liquids.
- uncontrolled emission of compressed gas
- sand under pressure.

148. To control the risks, employers should ensure:

- sand spillage is controlled
- exhaust systems are inspected and maintained regularly
- employees wear primary PPE

- compressed air is not used for cleaning unless the task cannot be done any other way, and ensure compressed air is never used to clean clothing or the body

Die making

149.

Furnaces and tools

150. Furnaces pose a risk to employees through excessive heat, fumes and the potential for accidents with molten metal.

Table 8: Furnace types and hazards

Furnace type	Description	Main hazards
Induction	A refractory lined vessel is surrounded by water-cooled copper coils. The coils conduct a current which heats the charge from the outside.	Metal fumes (controlled by a fume capture system or dilution ventilation) Induction furnaces generate least noise and heat.
Electric arc	The charge is melted by an electric arc drawn between it and three electrodes. The melt is poured by lifting the electrodes and tilting the furnace into a ladle.	Metal fumes (controlled by a fume capture system) Noise from the intermittent make and break of the arc
Crucible	A crucible is heated directly by electricity, gas or oil burner.	Explosions Carbon monoxide Metal fumes Noise Heat
Cupola	Coke, limestone and metal are layered into the furnace.	Carbon monoxide

151. Employers should ensure that appropriate controls are in place, including:

- ensuring services to the furnace can be shut off quickly and effectively (eg gas or oil supplies including hydraulic oil)
- preventing build-up of explosive gas or fuel by purging gas-fired and oil-fired furnaces
- preventing physical contact with hot furnaces or furnace parts by using barriers or other means such as doors that swing, pivot or slide in a way that directs hot surfaces away from employees
- ensuring 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.
- keeping reservoirs clean and dry
- ensuring employees not involved in furnace work stay outside of the area
- ensuring furnace dropping is done over a refractory floor or dry sand
- ensuring employees wear primary PPE (see page 43)

152. Furnace linings need to be inspected and maintained regularly, to prevent molten metal breakout. Energy sources should be locked and tagged out before machinery maintenance commences.

Ladles

153. Ladles can tip accidentally or be unstable. Controls include ensuring they have an integrated locking device, and installing safety devices to stop swinging or overturning of casting ladles with rigid ladle bails.

Furnace tools

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

155. Graphite tools are especially porous and absorb more moisture than traditional tools so they need to be preheated enough to eliminate the moisture.

156. To control the risks, employers should ensure that:

- tools are inspected for defects before being used
- tools are kept rust-free
- 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)
- ladles are repaired and relined in a designated area with dust extraction.

Charging metal into the furnace

157. Charging is the process of getting the raw material into the furnace. It is one of the most dangerous operations carried out in metal casting, with incidents ranging from minor injuries to fatalities and serious damage to plant and equipment. Depending on the type of furnace, hazards include:

- explosions
- metal fumes
- carbon monoxide and other toxic gases
- heat
- mobile plant
- noise
- hazardous manual handling
- contact with molten metal and hot surfaces.

158. 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.

159. 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.

160. Where reasonably practicable, employers should ensure that 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.

161. Employers need to ensure that employees wear primary PPE including regarding noise.

162. Controls for fumes include:

- high rooves which allow natural convection
- engineering controls to capture fumes, such as extractive hoods or canopies
- accurate furnace temperature control to prevent excessive melt fuming
- ensuring a safe distance between the furnace and operators, for example use screens and barriers to isolate personnel from potential fumes

Preheat charges

163. Water and other materials cause explosions when submerged below the surface of molten metal. 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.

164. 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.

165. 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.

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

167. To control the risks, employers should 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.

Adding substances to molten metal

168. Substances may be introduced to molten metal for processes such as alloying, fluxing, de-gassing or inoculation. Explosions may occur if moisture is present, if materials are not preheated or if substances react.

169. Employers should ensure that any substances to be added are:

- clearly identified to avoid the risk of mistaking them for something else
- presented in a way that allows for safe addition into the melt.

170. 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.

171. Employers need to ensure that employees who add substances to molten metal:

- are fully trained in the hazards of adding substances
- follow procedures recommended by the supplier

- are properly supervised by an employee who is fully trained in the hazards of adding substances.

Alloys

172. Alloying is the process of melting multiple metal elements together. 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.

Fluxes

173. Fluxes can be added to the melt for many reasons, including to:

- release metal from the dross to the melt
- help remove dross from furnace refractory linings
- remove inclusions
- remove alkali metals such as sodium, lithium and calcium
- prevent oxidation or hydrogen pick-up.

174. Many salt-based fluxes easily absorb moisture from the atmosphere and this can result in violent explosions if added to a melt.

175. To control the risks, employers should ensure:

- fluxes are stored in accordance with the manufacturer's instructions
- employees wear primary PPE - a respirator may also be required.

Skimming dross

176. 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.

177. To control risks, employers should ensure:

- moisture and contaminants are eliminated
- protective screens are fitted on the driver's cabin of mobile plant used in skimming operations
- tools and dross pans are clean and dry, have a refractory coating and are preheated before use
- employees wear primary PPE - a respirator may also be required (see page 42).

Testing and product evaluation

178. [Feedback from SFI member to make sure to include MPI (UV Lights) and first article inspection (Lasers)]

Moving molten metal

179. Risk controls need to be in place when moving molten metal around the workplace, regardless of how much metal is being moved. Putting a lid on the transfer vessel when practical is a good way of reducing spills and minimising heat loss.

180. Employers should ensure that:

- where reasonably practicable, mechanical aids (automation or mobile plant) 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
- the route used to transport molten metal is as short as possible, clear of other people and objects, and clearly marked
- a traffic management plan keeps people who don't need to be in the vicinity of molten metal movements at a safe distance

- where ladles are carried by hand, safe manual handling practices such as team lifts, 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
- 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 mobile plant

181. If mobile plant is used to move crucibles or receptacles of molten metal, the use of trailers, cranes, tugs or telehandlers is preferable. Forklifts should be a last resort, and bobcats or other unstable equipment are not appropriate. Employers should ensure that mobile plant:
    - has see-through heat-resistant splashguards (wind/blast shields) fitted between the driver's cabin and the load
    - that is electric-powered is used rather than gas or diesel, where possible
    - that is powered by gas has its gas line/couplings shielded with a heat-resistant guard
    - has sufficient load capabilities and sufficient safe lifting and reach requirements
    - uses appropriately designed and rated lifting attachments
    - has well-designed, appropriate cabin access and ergonomic seating
    - has solid (not pneumatic) tyres
    - has restraints fitted, which are used by the operator at all times
    - undergoes routine maintenance as specified by the manufacturer or supplier, including tyres, tynes and lifting attachments.

Slagging

182. Slagging is the process of removing debris from the melt, manually or using additives. Hazards include heat, hot metal splashes and radiation.

183. Employers should ensure that:
    - employees are protected by shielding
    - ventilation is positioned to draw fumes away from employees rather than through their breathing zone
    - employees wear primary PPE.

184. 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.

Casting

Tapping and pouring

185. Tapping and pouring involves transferring molten metal from the furnace and pouring into the moulds. Molten metal may also be manually tipped into a ladle, and then into moulds. Hazards include:

- explosions
- burns from radiant heat, splashes or spills
- eye damage
- hazardous manual handling
- fumes and dust (including RCS).

186. To control the risks, employers should ensure that:
    - others are kept away from the tapping and pouring area during the process
    - employees are protected by shielding or barriers
    - ventilation is positioned to draw fumes away from employees rather than through their breathing zone
    - employees wear primary PPE (**see page** 42), including respirators if necessary.

Die casting

187. When casting to a die, molten metal is mechanically injected from the furnace into the die. An employee may need to manually transfer molten metal from a holding furnace into the primary furnace using a small ladle. Hazards include:
    - burns from radiant heat, splashes or spills
    - plant (eg getting caught in machinery)
    - hazardous manual handling
    - fumes

188. To control the risks, employers should ensure that:
    - others are kept away from the die casting area during the process
    - extractor fans are clearing the fume effectively
    - separating employees from mobile plant
    - employees wear primary PPE and RPE (see page 42).

Molten metal spills

Containing flow

189. When a metal spill occurs, employee safety needs to be the primary focus. Potential risks include moisture, extreme heat, fumes, explosions, equipment failure, as well as burns from the molten metal itself. In addition, hot metal spills are very slippery, and if an employee falls, they may receive serious burns to the parts of their body that contact the floor.

190. Boots, shovels or hand tools should not be used to stop the flow. Water should not be used on metal spills.

191. To control the risks, employers should 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)
    - employees wear primary PPE (see page 42).

Cleaning up metal spills

192. Employers need to ensure that a procedure is in place to assess and clean up molten metal by experienced operators in correct safety gear.

193. 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 42).

194. 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.

195. To control the risks, employers should 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 42).

Removing castings

Shake out/knock out

196. Shake out/knock out involves removing a casting from its mould. For example, the sand mould may be placed on a vibrating screen where it is broken up and the sand falls into a collector from where it can be reclaimed. Hazards include:

- vibration from the knockout process or machinery
- atmospheric contaminants (eg RCS, phenolic resins)
- noise
- slips, trips and falls
- hazardous manual handling of castings, materials or tools (eg sledge hammers, pneumatic wedges)
- being trapped by moving machinery
- contact with hot castings and radiant heat
- falling objects (eg castings)
- low level radiation from zircon sand.

197. To control the risks, employers should ensure:

- adequate extraction of dust from shake-out tables, tumbling booths, rumbling machines etc
- lifting equipment is used to move heavy items (eg moulds)
- interlocked guards are used
- employees wear primary PPE.

Ejection from dies

198. Ejection of castings from die cast plant usually involves an ejection mechanism pushing the casting out of the die cavity, then the employee manually removing the casting. Hazards include:

- contact with hot castings and radiant heat
- hazardous manual handling – repeated movements
- machinery.

199. To control the risks, employers should ensure that:

- trolleys and conveyors are used
- plant has interlocked guards
- employees wear primary PPE

Cooling

200. When castings are cooling, traffic needs to be controlled around the area to prevent people coming into contact with hot surfaces. For example, physical barriers and signage can be used.

Moving castings

201. Employers should ensure that, where reasonably practicable, mechanical aids (automation or mobile plant) are used to transport castings.

Secondary processes (fettling)

202. Secondary processes are those required to produce the finished product after casting. They include processes for treating the cast metal, stripping away unwanted metal, and dressing the final casting, such as machining, rumbling, bulk finishing, punching, grinding, linishing and abrasive blasting.

203. Hazards from these processes include:

- noise and vibration. Very high levels of noise are common during manual fettling. It is not uncommon to find levels in excess of 110 dB(A). Risks of hearing damage are very high at these noise levels, with only 5 minutes of exposure exceeding the daily dose to exceed the workplace exposure standard.
- dusts and fumes
- sharp edges
- abrasives
- hazardous manual handling such as sustained awkward postures
- grinding and cutting machines
- cutting oils
- x-rays and ultraviolet light for inspection
- welding hazards
- acid hazards during pickling
- heat exposure (eg due to repetitive manual fettling)

204. Controls include:

- using automatic processes where possible – such as fettling robots, computer numerical control (CNC) grinding machines and automatic cropping
- replacing manual fettling with rough or even finish machining where possible – for example, chipping hammers can be replaced by grinders or linishers with mechanical extraction fitted
- tool supports/holders for finishing tasks
- minimising noise. In addition to engineering control measures like acoustic guards or enclosures, hearing protection may be mandatory in such areas.
- buying noise-reduced equipment (for example noise-reduced grinding discs)
- air exhausts in pneumatic systems are fitted with silencers where possible
- lining fettling booths with mineral wool
- lining or covering work surfaces and chutes with abrasion resistant rubber to reduce impact noise of falling castings where practicable
- rotating manual fettling work with short shifts for example to reduce heat exposure
- maintaining equipment for example keeping tools sharp and in good condition
- reducing the ringing of casting by clamping the piece, using rests on pedestal grinders or by using damping devices
- reducing vibration to a minimum through careful purchase of tools, correct operation and short

work periods

- considering use of air-cooled hoods as PPE to reduce heat exposure

205. Key hazards from grinding, abrasive blasting and rumbling are airborne contaminants and noise.

206. Control measures for grinding include:

- guarding grinding areas to minimise others' exposure to dust, particles and noise
- limiting where hand-held grinders are used for process work to as few areas in the workplace as possible
- ensuring facilities for the connection of fixed machines to dust-control equipment are incorporated in guard design
- guarding abrasive wheels on pedestal benches to control particulates
- ensuring tool rests incorporate a tongue piece, enclosing the wheel edge below the rest, to direct particles into the guard or dust control equipment.

207. Controls for abrasive blasting and rumbling include:

- using an exhaust ventilation system which operates when the enclosure or chamber is occupied, including during cleaning, maintenance and repair work
- ensuring 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
- ensuring a procedure is in place so remedial action is initiated immediately if faults or defects are identified in the ventilation system
- closing doors to the enclosure or chamber while blasting or rumbling is in progress
- fitting windows of impact-resistant and shatterproof glass to chambers to enable occupants to be clearly seen
- allowing enough time for the evacuation of abrasives and dust from the enclosure or chamber between finishing blasting or rumbling and opening the door
- ensuring employees do not enter or leave while blasting is being carried out
- ensuring controls can be operated from inside and outside the blasting area.

208. The OHS Regulations prohibit the use of abrasives containing more than one per cent of crystalline silica for abrasive blasting. <**OHS Regulations r153, Schedule 6**>

Housekeeping and maintenance

After casting

209. In foundries, when casting is complete, a number of tasks need to be done to ensure the foundry is safe for the next casting process.

210. Employers should ensure that:

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

Cleaning dusts

211. 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.

212. To control the risks, employers should ensure that:

- work practices and equipment produce a minimum of residue
- plant, fixtures and structures are cleaned regularly

- sand or earth floors 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 illness 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

213. To control the risks, employers should 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

214. To control the risks, employers should 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 metal casting area
- a register describing hazards and symptoms of exposure to materials and substances found in the workplace is created and maintained.

Furnace maintenance

215. Repair and relining of refractory furnace and ladle linings may involve knocking out or otherwise removing metal residue, slag and old refractory lining. Hazards include:

- working in confined spaces
- exposure to airborne hazardous substances such as RCS or metal dusts

216. To control risks, employers should ensure that:

- the space where furnace maintenance/relining is undertaken is designed in a way to readily access and ventilate the space
- remote control jackhammers for furnace maintenance/relining are used if possible
- energy sources are locked and tagged out before maintenance commences

Reclaiming materials

217. Sand reclamation can expose employees to RCS. Employers need to ensure that:

218. If metal off-cuts and castings are to be re-melted, they need to be inspected and stored in the same way as new materials. Risks include:

- manual handling; burns, cuts, abrasions

Part 5- Personal protective equipment in the foundry

219. Employers need to ensure that the necessary PPE is supplied to all employees, including labour-hire staff and contractors, and to anyone else entering the workplace. PPE needs to be replaced when it is no longer capable of providing the necessary protection (eg it is damaged or worn).

220. PPE is the least effective control measure for many risks, and more effective measures must be considered first. In many cases a combination of controls will provide the most effective level of control.

221. Employers need to provide information, instruction and training on the use, maintenance and storage of PPE to employees including labour-hire staff and contractors, and to anyone else entering the workplace.

Primary and secondary protective clothing

222. **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 illness in certain situations.

223. **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.

Fire-retardant clothing

224. 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.

	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.

225. 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.

226. 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 (Effective PPE program) for selection of appropriate PPE and implementing an effective PPE program.

Primary and secondary PPE for molten metal work

	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 Occupational noise management: Hearing protector program is provided in AS/NZS 1269.3.	
Eyes and face	Face shields with neck protection. 	Industrial safety glasses with side shields are the minimum. 
Respiratory	Respiratory protective equipment (RPE) 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.	
Trunk and arms	A jacket of leather or other suitably resistant material (eg aprons) needs to be worn outside all other clothing. It needs to be free of features such as cuffs and pockets that may trap molten metal. It needs to be worn properly and fastened at all times.	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 needs to 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. 	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 needs to 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.	Heat-resistant trousers.
Feet	[Primary, ie re molten metal] Safety footwear specifically designed for molten metal areas which prevent molten metal entering . Soles should have high temperature resistance; steel caps, metatarsal covers. No lace up boots or standard steel cap boots. Alternatively leather spats. [Secondary] Employees need to 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 needs to be given and the most appropriate alternative protective equipment sought.	

Figure 4: Primary protective clothing (Molten metal work)

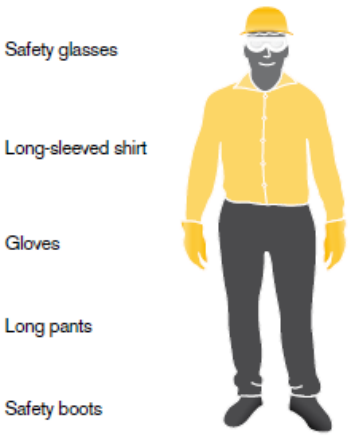


Figure 5: Secondary protective clothing (General foundry work)

Storage and care of protective equipment

227. Employers need to ensure:

- 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]