National Occupational Health and Safety Commission

FOUNDRY HEALTH

HAZARDS

December 1989

Australian Government Publishing Service
Canberra

WAP 89/040
GS 002-1989

ISBN 0 644 12819 4

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Printed in Australia by Craft Printing Industries Pty. Ltd. Enfield. NSW 2136

Foreword

The National Occupational Health and Safety Commission, Worksafe Australia, is a tripartite body established by the Commonwealth Government to develop, facilitate and implement a national approach to occupational health and safety.

The National Commission comprises representatives of the peak employee and employer bodies - the Australian Council of Trade Unions (ACTU) and Confederation of Australian Industry (CAI) - as well as the Commonwealth, State and Territory governments.

Since its establishment, the National Commission has produced occupational health guides. Before the National Commission was established, a series of similar guides was published by the National Health and Medical Research Council.

This Guide has been reviewed and endorsed by a working group of the National Commission as part of the co-ordinated effort by the Commonwealth, State and Territory governments and employee and employer organisations to make Australian workplaces safe and healthy.

Although this Guide has been endorsed by the National Commission, it is an advisory document only. It is produced and distributed in the interests of providing useful information on occupational health and safety for employers, employees and others. This document does not replace statutory requirements under relevant State and Territory legislation.

This Guide is aimed primarily at workers and managers but should also be useful to occupational health and safety personnel and others. It may be used in conjunction with appropriate training and consultation, in line with good management practice.

Contents

Introduction

This Guide should be read in conjunction with the following Worksafe Australia Guides:

- *Atmospheric Contaminants;*
- *Occupational Diseases of the Skin;* and
- *Prevention of Eye Damage.*

The National Commission publication, *Exposure Standards for Atmospheric Contaminants in the Occupational Environment* (latest edition), and the National Health and Medical Research Council publications, *Silica (Silicosis)* and *Effects of Heat on Health, Comfort and Performance*, should also be consulted.

Processes involved in foundry work

Founding, or casting, as it is commonly called, involves the pouring of molten metal into a mould made to the external shape of the article to be cast. The mould may contain a refractory core which determines the dimensions of any internal cavity or hollow. Molten metal is introduced into the mould. After cooling occurs, the mould is subjected to a 'shakeout' procedure which releases the casting and removes the core. The casting is then cleaned and any extraneous metal is removed from it.

Ferrous foundries produce iron and steel castings. Non-ferrous founding includes the casting of copper-based alloys (brass and bronze), aluminium, lead, zinc, magnesium and other alloys.

Identification

Moulding and pattern making

Sand moulds are commonly used for ferrous founding. To produce the depression in the sand into which the metal is poured, a pattern of the object to be cast is formed. Hardwoods, metals or resins are used by pattern makers in this forming process.

The majority of ferrous castings are produced by 'green' sand moulds. The moulding mix usually contains silica sand, coal dust, and organic binders such as dextrine and carbon oil. The moulding sand may also contain metal fragments from previous pourings as the sand is recycled. Water and binder are normally added to the sand before it is re-used. Synthetic resins are sometimes used in mould making.

The casting of non-ferrous metals often utilises graphite or metal dies in the moulding operation. The use of such dies requires specific procedures and safety precautions.

When working with sand and binder in mould or core making, use eye protection and gloves

Coremaking

Cores are traditionally formed of sand, with an organic binding agent added. The processing of these traditional cores involves oven curing, which releases acrolein, if oils are used, and produces a disagreeable, choking odour.

Several new binding systems contain various synthetic resins such as phenol formaldehyde, urea formaldehyde, furfuryl alcohol (furan), polyurethanes and various amines. The curing of these resins is achieved by chemical reaction or heating. Gases may be used as catalysts for reactions.

The mixing of sodium silicate with sand, and the passing of carbon dioxide through the mixed core, is also utilised. Silica gel and sodium carbonate are formed through this process which forms a rigid core.

The completed, cured cores are sprayed with a coating material prior to pouring. This may involve a combination of alcohol and graphite.

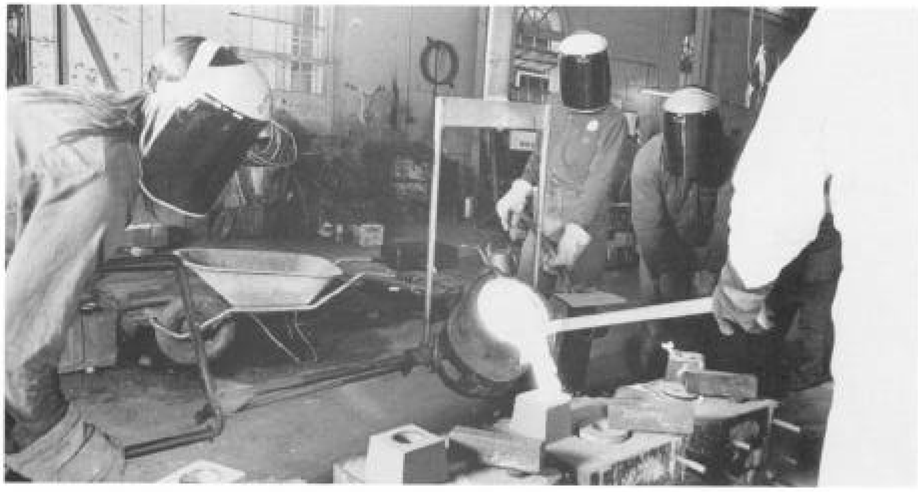
Melting and pouring

A variety of furnaces are used for melting metals prior to casting.

Electrically powered induction furnaces are used to process higher grades of cast iron and steel. These furnaces are almost noise free and generate little nuisance heat.

Some iron foundries utilise cupola furnaces. They are fuelled by coke, and compressed air is introduced to enhance the combustion. If the air is pre-heated, to about 300°C, the furnace is known as a 'hot-blast' cupola. Large amounts of carbon monoxide are generated during cupola operations.

Non-ferrous operations utilise electric furnaces, simple blast furnaces or, more commonly, reverberatory-type furnaces. Fume and dust collectors are incorporated into non-ferrous furnaces. Roasting ovens are used, in addition to furnaces, for refining copper and zinc.



When pouring molten metal, appropriate personal protective equipment and protective clothing should be worn

Electric holding furnaces are also used in foundries, to maintain the metals in the molten state prior to pouring.

The molten metal is poured from the furnace by tilting or tapping the furnace, and the metal is then passed to the moulds. In old or small foundries, the pouring of metal into moulds may be carried out manually. Larger foundries often have mechanised systems.

Shakeout (knockout)

The removal of the cooled casting from the mould is termed ‘shakeout’. The moulding sand is dry and friable at this stage, and particles of metal, sand and core material can become airborne during this process. While new foundries may have automated shakeout facilities, many smaller foundries do not, and the shakeout is performed manually. When the technique of ‘jobbing’ moulding is utilised, the moulds are knocked out by hand, usually with a hammer.

If coal dust is incorporated into a sand mould, carbon monoxide will be generated during cooling and shakeout.

Dressing and cleaning

Following the shakeout or knockout procedure, the formed castings are cleaned and dressed to remove any extraneous metal, sand or other material left from the moulding process. The castings are often sent to an allied machine shop at this stage for buffing and polishing. Various methods are employed in dressing and cleaning.

During dressing and cleaning of the castings, eye protection, face shields, goggles, earmuffs, respirators and gloves should be worn

Tumble blasting is now used extensively. In this process, the castings are mechanically tumbled with metallic abrasives in an enclosed drum. Abrasive blasting techniques are still utilised. A variety of non-metallic (corn husks, pecan shells, glass beads, silicon carbide and aluminium oxide) and metallic (steel grit or shot) abrasives are used. Water or air under pressure is used to deliver the abrasive to the surface of the casting. A great deal of dust is generated by this blasting, and it is usually carried out in an enclosure equipped with special ventilation and particle recycling facilities.

Pneumatic grinding and chipping tools may be used for cleaning castings. Hydraulic blasting or vibration processes may be employed to remove cores from the castings. In some foundries, additional grinding, polishing and buffing operations are carried out to develop a smooth polished surface on the metal.

Health Hazards

When considering the hazards associated with any workplace, it is essential to understand the relationship between ‘hazard’, ‘exposure’ and ‘risk’.

‘Hazard’ is the potential for an agent or process to do harm. ‘Risk’ is the likelihood that an agent will produce injury or disease under specified conditions.

Health effects can only occur if a worker is actually exposed to the hazard. The risk of injury or disease usually increases with the duration and frequency of exposure to the agent, and the intensity/concentration and toxicity of the agent.

Toxicity refers to the capacity of an agent to produce disease or injury. The evaluation of toxicity takes into account the route of exposure and the actual concentration of an agent in the body.

The various processes outlined in the preceding section give rise to heat, molten metal splashes, dusts, noise, gases and vapours in the foundry environment. If these hazards are not controlled or contained, serious health effects in exposed workers can result. Foundry work also involves various manual operations which carry a risk of physical injury.

Airborne contaminants: dusts

Silica dust

The lung disease silicosis can result from prolonged exposure to excessive concentrations of respirable, free crystalline silica dust. This dust is generated during mixing, moulding, shakeout and dressing operations, and during sand conditioning for re-use. The dust arises from quartz in the sand, and the concentration of free silica in the air varies with the handling process, the efficiency of dust control, the chemical composition of the sand and the physical state of the sand, that is, whether the sand is screened or unscreened, wet or dry. Used sand is either dumped or re-milled with water and binder added before it is re-used. The amount of respirable dust is increased by such re-use.

Sand is dry at the mixing or ‘mulling’ stage prior to mould making, and at the shakeout stage; this dry sand is potentially more hazardous than wet sand. Screened sand does not produce as much silica dust as unscreened sand, and pure quartz sand is more hazardous than olivine sand.

Formation of scar tissue, due to dust inhalation, interferes with lung function. Conditions such as tuberculosis and bronchitis may be complications of silicosis.

Note: **Cigarette smoking has a synergistic (enhancing) influence on the health effects of exposure to silica dust.**

Abrasive blasting processes may involve the use of sand containing high concentrations of free silica. The sand being cleaned from the castings may also present a silica hazard. Metal dust, which may be toxic, will be recycled along with the abrasive particles. Evaluation and control of such hazards therefore deserve particular attention.

Other dusts

Dusts other than silica, such as those arising from the use of chromite or olivine sand, have also been implicated as causing bronchitis and reduced lung function in foundry workers.

Airborne contaminants: gases, vapours and other contaminants

In addition to dusts, the air in foundries may contain the potential irritants formaldehyde, furfuryl alcohol, isocyanates, various amines and phenol. These contaminants are generated primarily by the coremaking and moulding processes, and may irritate the eyes and the respiratory tract.

Some hardwoods used in pattern making can release products which may cause asthma in exposed workers. Vapours from various resins can initiate severe allergic reactions.

Carbon monoxide gas is produced in substantial amounts by a variety of furnaces. It may also be released during the pouring of molten metal. Inhaled carbon monoxide prevents the blood from carrying a normal supply of oxygen. Exposure to concentrations of 500 to 1000 parts per million (ppm) for approximately 30 minutes may precipitate headache, accelerated breathing, nausea, dizziness and mental confusion. Thus a possible secondary effect of exposure is an increased risk of accident and injury to the worker. Exposure to higher concentrations (several 1000 ppm) may result in the appearance of symptoms after several minutes, or unconsciousness may occur rapidly without any warning symptoms.

Various metal fumes may be generated during founding processes, especially during melting and pouring operations. Lead, magnesium, zinc, copper, aluminium, cadmium, antimony, tin and beryllium fumes are commonly present in non-ferrous foundries. Iron oxide is the major fume generated in iron and steel operations.

'Metal fume fever' may result from exposure to these contaminants. This is an acute illness of short duration which commences some hours after inhalation of the metallic fumes. The initial symptoms are flu-like: nausea, headache, dry throat and coughing, and muscular pains. Chills and sweating may occur later. Recovery is usual within 24 hours after removal from exposure. The fumes of zinc and copper are the most common causes of metal fume fever.

The fumes and dust of cadmium, beryllium, nickel and chromium, contained in some alloys, are very toxic.

The melting and casting of lead-bronze and leaded steel may result in the emission of significant quantities of lead fumes. The lead hazard in furnace cleaning, dross disposal and the fettling of lead alloys deserves particular attention.

Exposure to vanadium pentoxide, a residual by-product, during oil-fired furnace and flue cleaning represents another substantial risk.

Skin irritants

Formaldehyde, isocyanates, various resin products, hardwoods and acids associated with pattern making and coremaking processes can irritate the skin and may precipitate allergic skin reactions.

Potential carcinogens

There is evidence from the International Agency for Research on Cancer that workers in iron and steel foundries may have an increased risk of developing lung cancer.

The exact substance responsible has not been identified, but the risks appear to be associated with dusts and/or fumes present in the foundry atmosphere.

The potential carcinogenic effects of dusts and fumes is a further reason for minimising atmospheric contamination.

Noise and vibration

Noise

Evaluation by occupational health and safety personnel of noise should be undertaken to identify areas where noise levels may be excessive. Surveys of foundries have shown that dressing, fettling and shakeout operations give rise to considerable noise levels, with potentially harmful effects on the hearing of exposed workers. In addition to the workers immediately involved in these processes, people working in the vicinity may be exposed to noise levels well in excess of 85 dB(A).

Some fettling workers have been shown to be exposed to levels of noise over 100 dB(A); shakeout and knockout processes are typically associated with readings of 90 - 110 dB(A). Mechanical sand mixing processes and forced draught furnaces may produce noise levels of 90 - 100 dB(A), averaged over an eight hour shift.

Extraction fans, diecasting machines, core-making and shell-making equipment may also be sources of excessive noise.

Vibration

Pneumatic grinding and chipping tools used in dressing the cooled castings may cause vibration-induced health effects in operators. Potentially hazardous vibration equipment may also be utilised in shakeout and core removal operations. Advice should be sought in these matters from a specialist in this field.

Heat and heat stress

Radiant heat is the major contributor to the heat load imposed on the worker by the environment. Convective heat transfer adds to this radiant heat. Protective clothing is worn for protection against the heat radiating from the heat sources and against contact with molten metal. Such clothing greatly restricts the potential for body heat loss via evaporation.

The foundry worker experiences a total heat load which is determined by the time spent at each workstation, the intensity of work, the clothing worn and the immediate workstation environment, including air circulation. If the heat load is sufficiently severe, effects on health and performance will occur. These range from decreased concentration to painful cramps, fainting, heat exhaustion and heatstroke. These signs and symptoms require immediate medical attention.

Heat stress can also aggravate the effects of exposure to other agents such as noise and carbon monoxide.

Physical injuries

Serious burns may result from splashes of molten metal in the melting and pouring areas of foundries.

Frequent, unprotected viewing of white-hot metals in furnaces and pouring areas may cause eye cataracts. Eye injuries from molten metal or fragments of metal may occur in pouring and dressing areas.

During continuous casting processes, non-ferrous molten metals, such as copper and aluminium, may explode violently if they contact water. Such explosions can occur in water-cooled furnaces; whenever spillages of molten metal occur; during the charging of furnaces with wet ingots or scrap metal; and whenever moist tools, moulds or other material come into contact with molten metal.

Injuries related to the manual handling of materials, and injuries due to falls, may occur. Grinding wheels used for dressing small articles may result in hand injuries.

Prevention and Control Measures

Following the identification of a hazard, evaluation of work practices and conditions must be undertaken so that effective prevention and control measures can be implemented. This should be considered an integral part of management's responsibilities.

Evaluation

Evaluation of the workplace environment should be included in an established program addressing prevention and control measures. Attention should be given to gases, vapours, fumes and dusts.

Environmental sampling and analysis should be undertaken at regular intervals by qualified occupational health and safety professionals in accordance with the methods recommended by the appropriate occupational health authority.

Monitoring

Monitoring may be used for the evaluation of a hazard and for assessing the effectiveness of control measures. The design and implementation of a monitoring program should be carried out by, or in consultation with, a properly qualified person.

Monitoring of the work environment involves the measurement of atmospheric contaminants at selected locations in the workplace (static, positional monitoring). Personal monitoring involves the measurement of atmospheric contaminants in the breathing zone of the individual worker. Biological monitoring involves measurement of the concentration of a contaminant, its metabolites or other indicators in the tissues or body fluids of the worker. In some cases, biological monitoring may be required to supplement static or personal monitoring.

When developing a monitoring program in foundries, due consideration should be given to heat stress, exposure to noise, gases, for example, carbon monoxide, vapours, fumes, for example, zinc and copper fumes, and dusts, for example, silica and olivine sand dusts.

In the control of health hazards due to a specific contaminant, where it has been demonstrated that the exposure of the employee to the contaminant is approaching the relevant exposure standard, or where biological monitoring indicates that an unacceptable exposure is occurring, *immediate action must be taken to reduce the health hazard* and intensive monitoring should continue.

Records of the results of any monitoring should be maintained and employees should be informed of these results.

Exposure standards

Worker exposure to dusts, gases and vapours should be kept as low as workable. Every attempt should be made to keep exposures well below the exposure standards recommended in the National Commission publication, *Exposure Standards for Atmospheric Contaminants in the Occupational Environment* (latest edition).

The exposure standards represent airborne concentrations of individual chemical substances which, according to current knowledge, should neither impair the health of, nor cause undue discomfort to, nearly all workers. Additionally, the exposure standards are believed to guard against narcosis or irritation which could precipitate industrial accidents.

Except where modified by consideration of excursion limits, exposure standards apply to long term exposure to a substance over an eight hour day for a normal working week, over an entire working life.

The exposure standards do not represent 'no-effect' levels which guarantee protection to every worker.

Control measures

Where there is a likelihood of worker exposure to foundry hazards, steps should be taken to minimise that exposure as far as workable. A thorough examination of work practices is essential. Procedures should be adopted to ensure that workers are not unnecessarily exposed to the hazard. Control measures include, but are not limited to, the following, which are ranked in priority of their effectiveness:

- elimination/substitution and process modification;
- engineering controls;
- administrative controls; and
- use of personal protective equipment.

Preventing physical injuries

An understanding, appreciation and application of prevention and control measures can contribute greatly to the minimisation of the risk of physical injury in foundry work. Some general principles are outlined below:

- Mechanically propelled vehicles or machinery should be inspected regularly, kept in efficient working order, and operated only by trained personnel.
- Maximum loads for winches, hoists, lifts and cranes should be clearly marked on the equipment. These maximum capacities must never be exceeded.
- Contact between molten metal and water must be avoided. All ladles and other equipment used for handling metal should be completely dry before contacting molten metal.
- Work areas should be checked regularly to ensure that good housekeeping practices are being followed.
- Any defective equipment should be repaired immediately or removed from service.
- Floors around furnaces should be of slip-resistant, non-combustible material, kept free of obstructions and cleaned regularly.
- Operating instructions for each furnace should be clearly displayed in the furnace area and issued to the person responsible for the furnace.
- Suitable protective clothing and equipment, including eye protection such as goggles, should be worn by furnace operators. This clothing and equipment should comply with the relevant Australian Standards.
- Eye protection should be required in all metal cleaning/dressing areas and should comply with the relevant Australian Standard.
- Barriers or other suitable shields against molten metal splashes should be installed where necessary.
- Persons should be prohibited from entering furnace areas when the temperature exceeds 50°C, except in cases of emergency.
- Foundries should be equipped with safety blankets, automatic emergency showers or hoses to extinguish burning clothing.
- Adequate lighting should be provided in all working areas in accordance with Australian Standard AS 1680.

- When machinery or equipment is being cleaned or maintenance carried out, lock-out devices or procedures should be employed to prevent the starting of the equipment.
- Workers who cannot be protected against falls from heights in any other way should be protected by wearing approved safety harnesses and lifelines.
- Self-contained breathing apparatus must be used in emergencies when high carbon monoxide concentrations are suspected.

Minimising exposure to dusts

Concentrations of silica dust, coal dust, metal fragments and other airborne contaminants should be controlled utilising the basic principles outlined in the Worksafe Australia Guide, *Atmospheric Contaminants.*

It may be necessary to substitute less hazardous sands, such as olivine sand, for quartz sand to reduce free silica concentrations. Local exhaust ventilation should be provided at the mixing or mulling stage as the sand is dry. This also applies to the shakeout operation. Sand, metal and coal dust at this point represent a major hazard. Carbon monoxide gas, from the combustion of coal dust, may be released at shakeout. It is desirable, therefore, to contain the shakeout process and exhaust the enclosure. If the mechanical ventilation in the foundry is not adequate in removing the dust at all points of contamination, the wearing of personal respiratory protective equipment, such as a face mask/respirator, is a complementary preventive measure. Such equipment should only be necessary when the provision of adequate exhaust ventilation is highly impractical, the materials or process cannot be replaced by less hazardous operations or during maintenance procedures.

Note: **It should be noted, however, that in the 'tear-down' and rebuilding of furnaces, kilns and ovens, the material is often a ceramic material. Depending upon the free silica content, the risk of developing silicosis over years of exposure must be dealt with and adequate precautions, such as ventilation and personal protective equipment, must be taken. It is also likely that various types of asbestos may have been used as a shield, insulator or heat-resisting material. Should this be found, precautions to eliminate the exposure must be taken. These include substitution of material, the use of ventilation and personal protective equipment such as respirators.**

Abrasive blasting and cleaning operations require special consideration. Silica-based polishing pastes should not be used in metal cleaning operations. Total enclosure of abrasive and cleaning operations should be provided, together with local exhaust ventilation. If operators are required to work inside the enclosure, a continuous-flow, air-line respirator must be worn. All such equipment must be regularly maintained.

Minimising exposure to gases and vapours

Carbon monoxide

Carbon monoxide, being colourless and odourless, has no warning properties. The only way to determine the concentration of the gas is by regularly monitoring the foundry air. Automatic alarms are a good means of warning workers of dangerous carbon monoxide levels, provided that they are correctly adjusted.

Exhaust ventilation is a means of controlling carbon monoxide emissions at their source. For cupola furnaces, the exhaust intake should be located well behind the stack.

All potentially exposed workers should be instructed in the dangers, recognition and treatment of carbon monoxide poisoning. The biological monitoring of carbon monoxide via blood sampling or in exhaled air samples may be a useful technique. The samples should be taken at the end of a working shift.

Other gases and vapours

Potentially irritant vapours or fumes generated in coremaking or moulding processes should be collected by exhaust ventilation at the point of emission and disposed of in accordance with environmental protection requirements. Special consideration should be given to combustion products formed during the pouring of moulds.

Metal fumes should be removed in the same way. Exhaust ventilation should be provided at the top of the pot in the founding of non-ferrous metals such as aluminium, magnesium and copper.

It may be possible to substitute less hazardous substances, or otherwise modify the process, to minimise the generation of hazardous fumes, gases or vapours.

The use of gases such as sulphur dioxide or chlorine for degassing molten metals requires special attention to safety and ventilation.

Skin irritants

Gloves complying with the relevant Australian Standard should be worn by moulders when handling synthetic resins or any other materials which are skin irritants or sensitisers.

Minimising the risk of heat illness

It is important to identify those workers who are frequently exposed to high levels of heat and are particularly at risk of suffering heat-induced illness. Workers in furnace and pouring areas are often exposed to high levels of heat.

People who have any history of heat intolerance or a circulatory disorder, anyone recovering from a fever, and any dehydrated worker must be regarded as being in a high-risk category for heat illness. All workers who are exposed to heat at work should be encouraged to be physically fit and to achieve their ideal body weight. Certain tranquillisers, motion sickness medications and alcohol may impair temperature regulation mechanisms.

It should be noted that physical fitness and acclimatisation are not identical qualities. Even a very fit person who has not been previously exposed to hot conditions may display intolerance to working in the heat. Unacclimatised persons must be given time to acclimatise to work in the heat. It is recommended that those who have not previously been exposed to work in hot conditions should begin with half of the anticipated workload and half of the normal exposure time on their first day. The exposure can then be gradually increased to the total workload/time combination on the sixth day. Previously acclimatised personnel who return to work in the heat after an absence of approximately nine or more consecutive days should undergo a four day re-acclimatisation period, commencing with half of the regular workload and half of the normal exposure time as outlined previously.

Planned job rotation can assist in reducing exposure to heat. It may be necessary to place some workers at cooler workstations for periods of time or to transfer them permanently to more moderate environments.

Cool water should always be available in close proximity to hot working areas and encouragement given for the use of these facilities. Adequate rest breaks should be taken, as outlined in the National Health and Medical Research Council publication, *Effects of Heat on Health, Comfort and Performance*.

The exposure of workers to radiant heat can be reduced by the strategic positioning of shields between workstations and heat sources. Clothing should be carefully selected so that a balance between protection and facilitation of heat loss through evaporation is achieved. Attention to ventilation and the provision of adequate air movement is essential. Some hot processes, for example, pouring, may be partially or fully enclosed to reduce heat exposure.

Heatstroke, the most serious effect of heat, is associated with failure of the normal temperature regulating mechanisms. The condition is characterised by hot dry skin, mental confusion, loss of consciousness, convulsions and eventually coma. Deep body temperature is often higher than 41°C, and rising. Onset is often rapid.

Note: **Heatstroke is usually fatal if not treated. The heatstroke victim must be cooled *immediately* by removing clothes, spraying with cold water and fanning vigorously to assist evaporation. This should be carried out in a cool area and must continue until medical attention is obtained. Body temperature should be reduced to 38°C before the patient is moved to hospital.**

Noise reduction / occupational hearing conservation

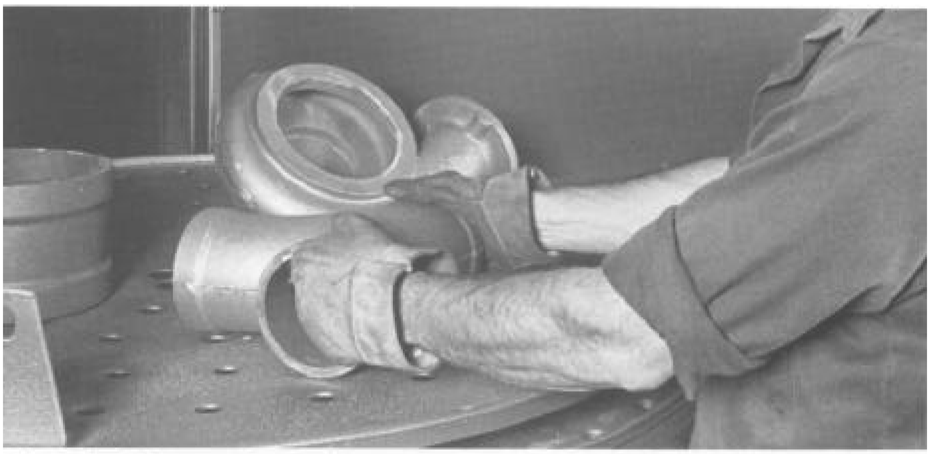
The reduction of noise at the source or in the transmission path should be achieved wherever workable. A complete hearing conservation program, incorporating education, engineering controls and routine audiometric tests, should be implemented. Australian Standard AS 1269 provides information on the measurement, evaluation and control of noise.

Vibration

Engineering controls or substitution of processes should be utilised wherever possible to minimise worker exposure to vibration. The wearing of padded gloves is a complementary control measure.

Manual handling

Various foundry operations involve the lifting, carrying and stacking of heavy objects. Attention should be given to ergonomic principles and the proper methods of manual handling should be followed.



Gloves should be worn when handling castings to reduce the likelihood of injuries to the hands

Personal protective equipment

In certain circumstances, personal protection of the individual may be required as a supplement to other preventive action. It should not be regarded as a substitute for other control measures and must only be used in conjunction with substitution and elimination measures.

Personal protective equipment must be appropriately selected, individually fitted and workers trained in their correct use and maintenance. Personal protective equipment must be regularly checked and maintained to ensure that the worker is being protected.

Education and training

All employees working with foundry hazards must be informed of the hazards and the precautions necessary to prevent damage to their health. Employees exposed to contaminants should be trained in appropriate procedures to ensure that they carry out their work so that as little contamination as possible is produced, and in the importance of the proper use of all safeguards against exposure to themselves and their fellow workers. Adequate training, both in the proper execution of the task and in the use of all associated engineering controls, as well as of any personal protective equipment, is essential.

Employees exposed to contamination hazards should be educated in the need for, and proper use of, facilities, clothing and equipment and thereby maintain a high standard of personal cleanliness. Special attention should be given to ensuring that all personnel understand instructions, especially newly recruited employees and those with English-language difficulties, where they are known.

Material safety data sheets should be obtained for all substances from the suppliers of such materials before handling.

A management representative should be nominated as responsible for personal protective equipment supply, maintenance and training.

Health assessment

In some occupations, health assessment may form part of a comprehensive occupational health and safety strategy. Where employees are to undergo health assessment, there should be adequate consultation prior to the introduction of any such program. Where medical records are kept, they must be confidential. It is particularly valuable to be able to relate employee health and illness data to exposure levels in the workplace.

First Aid

First aid procedures and facilities relevant to the needs of the particular workplace should be laid down and provided in consultation with an occupational physician or other health professional.

Due to the nature of foundry work, medical emergencies such as burns, heat stroke, eye injury or carbon monoxide poisoning are sufficiently probable to warrant the development of special procedures and the provision of emergency equipment.

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