EPA Guidelines

Environmental management of foundries

Updated August 2008

EPA 121/08: This guideline provides information to the foundry industry to assist with compliance with the provisions of the* Environment Protection Act 1993 *and associated legislation.

Introduction

The foundry industry in South Australia employs around 2000 people and supplies many downstream industries. It is therefore an important economic asset to the State.

However, the environmental impact of a foundry can be significant, especially when it is close to residential areas. While regulation under the *Environment Protection Act 1993* (the Act) seeks to minimise environmental impact, it is also imperative that foundries employ Best Practice Environmental Management to ensure the long-term sustainability of the industry.

Environment Protection Act 1993

The principal legislation addressing pollution in South Australia is the *Environment Protection Act 1993*. In particular, section 25 imposes the general environmental duty on all persons undertaking an activity that pollutes (or might pollute) to take all reasonable and practicable measures to prevent or minimise any resulting environmental harm.

Metal melting is a *Prescribed Activity of Environmental Significance* under Schedule 1 of the Act. Foundries with a capacity to melt in excess of 500 kilograms of metal per production cycle require an authorisation in the form of a licence.

Environment protection legislation also includes Environment Protection Policies (EPP), which outline recommendations and mandatory requirements for the protection of a particular aspect of the environment, such as air quality.

Environment Protection (Air Quality) Policy 1994

Regulation of air pollution is primarily governed through the *Environment Protection (Air Quality) Policy 1994* (Air Policy). Section 4 of the Air Policy requires that the best practicable means of control be used to minimise air pollution from an activity.

EPA South Australia

The Air Policy also specifies maximum pollution levels in the Schedule to the policy. You are referred to the Environment Protection Authority (EPA) Guideline *Air quality impact assessment using design ground level pollutant concentrations*, which provides guidance and criteria for proponents of new developments that may emit pollutants to the atmosphere. The information is also relevant to existing facilities seeking to determine the ground level impact caused by their emissions. Foundries must be able to show that their emissions are below the levels shown in this guideline or that they have an environment improvement program (EIP) in place that will enable them to reach these levels within a timeframe acceptable to the EPA.

You are also referred to the EPA Guideline *Odour assessment using odour source modelling*, which provides guidance and criteria for the management of odour emissions, both for new or expanding developments and for existing developments seeking to upgrade their processes.

Environment Protection (Water Quality) Policy 2003

The Environment Protection (Water Quality) Policy 2003 (Water Quality Policy) applies to all inland surface and ground waters, and marine waters and is effective from 1 October 2003. It will cover:

- water quality objectives
- management and control of point and diffuse sources of pollution
- obligations relating to particular activities
- criteria, discharge limits and listed pollutants.

Industrial operators must ensure that waste generated at the premises is not discharged into any waters or onto land where it is reasonably likely to enter any waters (eg by seepage, runoff or infiltration).

Environment Protection (Noise) Policy 2007

The *Environment Protection (Noise) Policy 2007* provides guidance on noise levels that may be deemed excessive under the Act. It should be noted that the Act requires site specific issues be taken into account when determining noise levels that may be excessive.

It is important to ensure that all practicable steps are taken to minimise the adverse effect that noise emissions may have on the amenity value of an area. This responsibility includes not only the noise emitted from the plant and equipment but also associated noise sources, such as radios, loudspeakers and alarms.

Commercial and industrial premises must not allow excessive noise to be emitted from the premises. The EPA may issue an Environment Protection Order requiring that the excessive noise be curtailed within a specified period.

Scope of this guideline

The scope of this guideline is the management of standards for emissions in the waste streams of all foundries operating in South Australia, that is:

- air quality (dust, fumes, furnace emissions, odour etc)
- noise
- waste generation and disposal

- water discharges
- stormwater
- site disclosure.

Notwithstanding any requirement contained in these guidelines, all foundries must seek to comply with the statutory requirements under the Act.

It is recommended that foundries give due consideration to implementing 'eco-efficient' approaches when making environmental management decisions.

Pollution control (refer to Appendix 1 for definitions)

Releases into the atmosphere

Air pollution is a major environmental problem for foundries. The most significant releases to air are:

- VOCs (including partially oxidised hydrocarbons) and odorous substances from mould production, casting, cooling and knocking out
- dust and fumes from melting, hot metal transfer and casting
- dust and fumes from materials handling and finishing operations
- dioxins and other persistent organohalogens, which may be produced during the melting of scrap contaminated with paint, plastics or lubricating oil
- lead, zinc, cadmium and other heavy metals released and concentrated in bag filter dusts or wet scrubber liquors and sludges.

Processes for the production, treatment or handling of liquid metals can generate dust and fumes. In line with eco-efficiency principles, the first objective should be to prevent these emissions or to capture them before their release.

There are three main techniques available:

- suppression at source
- local containment
- remote extraction.

A combination of these techniques can be adopted in furnace areas if the discharge of untreated dust and fumes is to be avoided. Emissions may be suppressed at source by keeping air away from molten metal or slag by placing covers over runners and using an inert atmosphere at transfer points (from the furnace to transfer vessel or storage). This is the preferred method for suppression of emissions for new and existing processes, where designs can be shown to be fully effective.

Local containment is generally satisfactory for primary fume extraction when shown to be fully effective. For secondary fume release, it can be difficult to design local containment and extraction which can cope with fumes generated intensely over short periods of time (eg nodularisation of SG iron[1]), and which does not impede operations such as overhead crane movements. In these circumstances consideration should be given to full or partial sealing of the foundry building and roof, and the use of high level extraction.

---

[1] spheroidal graphite iron

Intermittent roof discharges of visible fumes from primary, secondary or fugitive releases should be avoided. Where existing plants fail to meet this criterion, EIPs designed to comply with this standard of environmental control may be included as a condition of licence.

Mould and core preparation

Mould release agents can contain organic solvents and binders and chlorinated substances. The use of these agents should be reviewed against less harmful alternatives and their continued use justified to the satisfaction of the EPA.

Green sand moulding methods release dust during mixing. This should be extracted and collected and then treated in a suitable air-cleaning unit.

Resin bonded processes use a variety of resins and catalysts. The cold box method uses a gaseous catalyst, such as amine or sulfur dioxide, which must be collected in a suitable scrubbing unit. Where wet scrubbing is used, a suitable discharge route must be used for the underflow liquor.

Emissions of VOCs from solvents in chemical resins are generally of a sufficiently low level to render scrubbing unnecessary. However, emissions should be prevented or minimised by careful selection of sand binding agents.

Static mould casting

Wherever possible, casting fumes and emissions should be captured and cleaned. During casting, emissions of VOCs and partially oxidised hydrocarbons arise from the mould. The moulding process will have been chosen for cost and technical reasons but, wherever possible, the most environmentally acceptable process should be adopted.

Foundry operators will be required to assess both the VOCs emitted and the emission method, that is, whether the VOCs are emitted as soon as the hot metal is poured or are released slowly during the cooling period. With this information the EPA will be able to assess whether any local extraction is required or feasible.

For new processes it is clearly preferable for moulds to be moved under the pouring station, a method in which extraction can be more readily applied than when a ladle is moved over the moulds.

While roof extraction may be a solution for the collection of fumes, it may not be an appropriate option for VOCs. Abatement systems that can remove VOCs may be rendered ineffective by dilution of the VOCs in large quantities of air. The exact nature and extent of the problem will have to be analysed at each site in order to establish the most appropriate technique to be used.

Knocking out and mould stripping practice

Where mechanical vibration is used, the equipment should be enclosed and the air extracted and filtered.

The practice of shot blasting should be undertaken within a totally enclosed unit, with the dust being collected and treated in a suitable filter unit.

Fettling and finishing

Fettling involves the generation of dust which, when produced on a significant scale, should be ducted to a filter unit. Flame cutting and arc/air scarfing should be undertaken with extraction to a filter unit.

Dispersion from stacks, roof vents and building emissions

Foundry operators will need to satisfy the EPA that an appropriate assessment of vent and stack emissions has been made. Adequate dispersion of untreated fumes and odour released to the atmosphere must be achieved.

There are many dispersion models available that can predict impacts of vent and stack emissions, of which 'Ausplume' is generally favoured for regulatory use. When matched to a post-processor program, Ausplume can provide graphical representations that are useful in illustrating the impacts associated with a given project.

Ausplume may not be suitable for dispersion modelling in cases where complex terrain may cause wind channelling, or where there is the potential for slope flows, recirculation or sea breezes to affect dispersion. In these cases, other models such as the diagnostic model 'Calpuff' and prognostic model 'TAPM' may be used

Modelling will be increasingly important for sites with significant non-combustion sources, any large volume emission, or multiple release points. Foundries should provide clear information on the parameters used and the assumptions made in their use of dispersion models. Normally, at least 12 months of representative hourly meteorological data is needed. Variation from this minimum shall be permitted only with the agreement of the EPA.

Where appropriate the applicant should also recognise that the stack or vent may act as an emergency release point. Process upsets or equipment failure giving rise to abnormally high emissions over short periods should be assessed. Even if the applicant can demonstrate a very low probability of equipment failure giving rise to high emissions, the stack or vent height should still be sufficient to avoid environmental harm or nuisance.

Releases into water

Aqueous waste may contain:

- inorganic metal compounds
- organic compounds
- particulate matter.

Process waters, emergency fire water and chemically contaminated water should be contained and discharged to the sewer after gaining approval from SA Water. If sewer disposal is not possible then these waste streams should be kept separate for easier management and may have to be removed from the premises by a contractor licensed to carry this waste.

The amount of process water used in foundries is small, comprising principally:

- discharge and blowdown from wet scrubbers
- cooling water, often containing biocides and anti-oxidants
- leachate from slag and waste tips.

Process water is not suitable for discharge to the stormwater system.

Minimising the use of water and the level of pollutants in each wastewater stream are the primary aims, followed by the recycling of wastewater streams whenever possible. In foundries, treating the water to 35 milligrams per litre of suspended solids is likely to ensure that most of the insoluble pollutants will be within acceptable limits. Such treated water is likely to be of good quality and should be considered for recycling; however, it should be tested to determine the levels of dissolved chemicals. This will ensure that the recycling of this water is an appropriate alternative.

Runoff from open areas, but in particular from raw material stocking areas, will contain suspended solids that will have to be removed by settlement or other techniques prior to disposal to any off-site stormwater system. Oil interceptors may be necessary in drainage from scrap handling areas. Drainage sumps should be of sufficient capacity to handle stormwater and should be designed to handle storm surge in order to prevent carryover of unsettled material to stormwater systems.

Bunding is a sensible precaution in most cases. It is essential in many cases where there is a risk to controlled waters, sewers and drains and on-site effluent treatment plants. Shared bunds are possible in cases where the materials stored are not incompatible. Bund capacities should meet the requirements of the Australian standards or the EPA Guidelines *Bunding and spill management*.

Areas where spillage is most likely to occur, such as storage tanks and sampling points, should be bunded and drain to sumps. Wastes collected in bunds should generally be considered contaminated and not suitable for discharge to the stormwater system. The composition of any wastes collected should be determined prior to treatment or disposal. Bunds not frequently inspected should be fitted with a high level probe and an alarm where appropriate.

The integrity of storage tanks and bunds should be checked and documented regularly, particularly where corrosive substances are involved. Procedures for preventing unauthorised discharges or leakage from bunds should be in place.

Where it is considered inappropriate to bund a particular storage tank or process vessel, the foundry must justify this approach.

Wastes to landfill

The foundry should identify the key pollutants likely to be present in wastes to landfill, using knowledge of the materials used in production and plant maintenance. All of the dust and slags arising from the process should be identified, and should be validated as necessary by appropriate analytical techniques and material safety data sheets.

The presence of materials created by abnormal operation should also be identified, since process abnormalities can carry substances normally not present through into solid waste.

Solid waste generated by foundries generally falls into the following three categories.

Production waste

Includes risers, runners and defective or off-specification products. These wastes are almost always recycled within the foundry.

Used foundry sand (UFS)

Sand is the primary constituent of moulds and cores used in the production of both ferrous and non-ferrous castings. In most foundries the majority of UFS is disposed to landfill. Depending on the binding agents used to make the moulds and cores, a number of sand reclamation and internal recycling options exist. These options should be considered where feasible.

Similarly, options for the recycling of used foundry sand for external applications, such as a component of road base or other suitable means of reuse, should also be considered. You are referred to EPA Guideline *Used foundry sand (UFS) – classification and disposal*.

Slag waste

Raw and recycled materials are used as feedstock to foundry furnaces. As the scrap metal melts, impurities contained within the feedstock form a separate slag phase. The composition of slag depends on the components added to the furnace charge and any associated impurities. The quantity of slag produced can be minimised through the use of clean and uncontaminated scrap metal as a feedstock.

Compliance monitoring program

General

Foundry operators need to show they are aware of their discharges and have the necessary documented evidence in place to show these are monitored on a regular basis. The management of environmental information can be greatly assisted by the implementation of an environmental management system (EMS). An EMS provides a structured means of managing environmental impacts and is the first step towards environmental improvement—an EMS benchmarks environmental performance and then continually evaluates improvement.

Monitoring requirements for release to atmosphere

Foundry operators will need to carry out a regular air-monitoring program, which should be repeated on an annual basis to develop a baseline of emissions to the atmosphere. Parameters likely to be tested for are listed in the EPA Guideline *Air quality impact assessment using design ground level pollutant concentrations*.

Potentially significant pollutants are:

- particulate matter
- oxides of nitrogen
- oxides of carbon
- iron and its oxides
- heavy metals
- ammonia
- VOCs, including formaldehyde, phenol and esters
- dioxins where dirty scrap is used
- odour.

Monitoring requirements for releases to water

Process effluent released to controlled waters and sewers will commonly be monitored for the following:

- flow rate in metres per second
- pH—the acidity or alkalinity of the effluent, measured in pH units ranging from 1 to 14. A pH of 1 is highly acidic, 14 is highly alkaline and 7 is neutral.
- temperature in degrees Celsius
- total organic carbon (TOC)
- chemical oxygen demand (COD)
- biochemical oxygen demand (BOD)
- turbidity
- dissolved oxygen.

In addition to regular monitoring to demonstrate compliance with the release limits set, the foundry should also carry out a broader analysis, covering a wider spectrum of substances, to confirm that all relevant substances have been taken into account when setting the release limits.

Monitoring requirements for wastes to landfill

Foundry operators should record and advise the EPA of the quantity and composition (including prescribed substances) of wastes released to landfill.

The foundry should have written procedures that ensure that wastes are handled, treated and disposed of in an approved manner. They will also need to specify how the accumulation and storage of wastes are controlled.

Records and reporting

Foundry operators are to keep and maintain all records relating to emissions, waste, maintenance and environmental incidents. The EPA licence coordinator will review these records when carrying out on-site inspections.

Environmental audits

Foundry operators should carry out environmental audits on all their activities on a regular basis (at least annually). These audits will help to ensure that standards are maintained and will identify opportunities for ongoing improvement.

Environment improvement program

As part of their program of ongoing improvement, a foundry should put in place an EIP, which should address outstanding issues using information obtained from audits.

Site closure

Many foundries operating close to residential areas lack sufficient space for their operations or have experienced pressure to reduce their impacts; this has lead some foundries to consider moving to an alternative location. Many foundry sites have been subject to use for long periods of time and considerable contamination of the site may have occurred over this period. Foundry operators need to ensure that sufficient funds are set aside for site closure and cleanup.

Currency of these guidelines

These guidelines offer advice to assist with compliance with the general environmental duty and specific environmental policies. They are subject to amendment and persons relying on the information should check with the EPA to ensure that it is current at any given time.

FURTHER INFORMATION

Legislation

Legislation may be viewed on the internet at: <www.legislation.sa.gov.au>

Copies of legislation are available for purchase from:

Service SA Government Legislation Outlet	Telephone:	13 23 24
101 Grenfell Street	Facsimile:	(08) 8204 1909
Adelaide SA 5000	Internet:	<shop.service.sa.gov.au>

For general information please contact:

Environment Protection Authority	Telephone:	(08) 8204 2004
GPO Box 2607	Facsimile:	(08) 8124 4670
Adelaide SA 5001	Freecall (country):	1800 623 445
	Internet:	<www.epa.sa.gov.au>
	Email:	<epainfo@epa.sa.gov.au>

Appendix 1 Definitions

Air gas furnace Usually a rectangular shaped furnace in which an air and gas mixture is used to raise a metal bath to a sufficient temperature for casting.

Air set sand Sand that is coated with a resin and a catalyst. When packed around a pattern, it sets in air to form a rigid mould able to withstand the casting pressures of molten metal. Bench life usually 10–20 minutes after the removal of the pattern.

Arc furnace A furnace where carbon electrodes are used to form an arc between the electrodes and a bed of scrap material to create a molten metal bath.
It is used in South Australia for melting steel.

Cold box sand Sand that is coated with a resin and a catalyst and formed into a mould or core, through which a gas setting agent is passed to form a rigid shape.

Core A sand shape which is inserted into a mould to form an additional profile, hollow or cavity in a casting.

Corebox Tooling used to make a core.

Cupola A refractory lined stack into which layers of metallurgical coke, steel scrap, cast iron scrap, pig iron and limestone are charged. The coke is ignited and the furnace temperature raised by the use of a forced air blast.
This is a continuous furnace and melting will continue as long as raw materials are charged into the top of the stack.
It is only used for the melting of cast iron.

Die casting (permanent mould) process A process using a cavity machined into a metal mould into which molten metal is formed. These moulds are used many times over.

Green sand Sand, clay and water mixed together and rammed around a pattern; the clay forms a sufficient bond for a mould to be formed.
After casting this sand mixture is reconstituted by the addition of moisture and can be reused as a moulding medium. (Additions to green sand can be coal dust, dextrose or other specialist additions).

Hot box process A sand, resin and catalyst mixture which is blown into a heated corebox (approx. 180° Celsius). The heat acts to set the resin mixture, giving a strong sand core.

Induction furnace Cylindrical furnace using a water-cooled electrical induction coil to induce heat into a scrap metal charge, increasing its temperature beyond melting point. Used for melting steel, iron and copper based alloys.

Mould A cavity of sand or metal into which molten metal is poured to form a casting.

Pattern Tooling used to form a mould.

Shell process A process using a mixture of sand and a phenolic resin which is either poured over a heated pattern or blown into a heated corebox. This is then inverted such that uncured sand drops off, giving a biscuit or shell of hard sand.

Sodium silicate (CO_2) process	A process using a mixture of sand and sodium which bonds by silicon bonding when CO_2 gas is passed through the sand. Alternatively, an ester can be mixed into the sand, creating an air setting mixture which cures in about 30 minutes.
VOC	Volatile organic compound.

Appendix 2 Fumes emitted from current foundry processes

Moulding system and additives	Setting method	Fumes during moulding	Fumes during casting
Green sand Clay Coal dust Water	Pressure	Dust	Oxides of carbon Aromatics (incl. polycyclics) Nitro aromatics
Shell sand Phenol Formaldehyde Resin	Heat	Formaldehyde Ammonia Phenol Aromatics	Oxides of carbon Phenols Ammonia Aldehydes Aromatics (incl. polycyclics)
Alkali phenolic Alkaline phenol Formaldehyde resin 1. Self-setting, eg 'Novaset' 2. Gas hardened, eg 'betaset'	Cold set with esters Gas hardened with methyl formate vapour	Formaldehyde Phenol Esters Formaldehyde Phenol Methyl formate	Aromatics Phenol Formaldehyde Oxides of carbon
Phenolic urethane 1 Self-setting, eg 'pepset' 2 Gas hardened, eg 'Isocure'	Cold set with substituted pyridine Amine vapour	Solvents Isocyanates (MDI) Solvents Isocyanates (MDI) Amine	Oxides of carbon Oxides of nitrogen Monoisocyanates Formaldehyde Phenol Aromatics (incl. polycyclics) Anilines Naphthalenes Ammonia
Furane Combination resins of: Phenol Urea Furfuryl alcohol Formaldehyde	Cold set with acids	Formaldehyde Phenol Furfuryl alcohol Hydrogen sulphide Sulphur dioxide Acid mists	Oxides of carbon Phenol Formaldehyde Aromatics Sulphur dioxide Ammonia Aniline
Hot box Combination resins of: Phenol Urea Furfuryl alcohol Formaldehyde	Heat	Formaldehyde acids Furfuryl alcohol Phenol	Oxides of carbon Oxides of nitrogen Formaldehyde Phenol Aromatics Aniline Ammonia

Moulding system and additives	Setting method	Fumes during moulding	Fumes during casting
Oil sand Linseed oil and starch	Heat	Acrolein Complex organics	Oxides of carbon Butadiene ketones Acrolein
CO2 process Sodium silicate	Gas hardened with CO2 gas	None	Oxides of carbon
Silicate ester 'Self-set' Sodium silicate	Cold set with esters	Esters	Oxides of carbon Alkanes Acetones Acetic acid Acrolein

Appendix 3 Sources of pollution

Emissions to air

Dust

- charging of furnaces
- movement of scrap
- oxidation of furnaces
- knocking out of castings from moulds
- media drums
- mould shake out units
- sand conveyor transfer points
- pneumatic transfer of sand
- traffic—forklift trucks, front-end loaders
- grinding of casting
- chipping hammers
- shot blast cabinets.

- ***Fumes***
  transfer of molten metal
- treatment of molten metal
- overheating of furnace baths
- casting of molten metal
- heating of sand and resin mixtures
- chemical reactions involved in the air and gas curing of sand and metal mixtures
- arc/air process
- oxy-acetylene burning.

Odour

Generated by all processes, major sources being:

- during casting and mould cooling
- curing of sand resin mixtures by air, heat or gas
- sand resin mixing and moulding
- grinding and metallic smells
- melting of contaminated scrap
- spray painting, coating
- metallic coating.

Noise

Generated by many processes, including the following:

- high frequency noise from induction furnaces
- noise from fans
- metallic noises from tipping and dropping castings
- shot blast booths
- overhead cranes

- fork lift trucks, day and night
- process noises such as moulding machines, conveyors, vibrators, shake outs, media drums, grinders, cut-off saws, core blowers
- arc air process continuous noise
- arc furnace start up
- compressed air used for blowing off
- compressed air leaks.

Water discharge

Foundries use little process water; nevertheless, the following areas need to be considered:

- blowdown water from cooling towers
- water from quenching tanks
- water used to wash down floors
- water used for cleaning of machinery of vehicles
- blowdown water from wet scrubbers
- spent green sand
- resin bonded sand
- slag
- general waste
- oils and greases
- chemicals
- hazardous waste
- baghouse dust.

Stormwater

Can be polluted by:

- roofs contaminated with dust
- open spaces and work areas subject to resin and chemical spills, foundry sand etc.