Cleaner Production Self Assessment Guide

Metal Casting Industries

The UNEP Centre for Cleaner Production

and

The CRC for Waste Minimisation and Pollution Control, Ltd

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CLEANER PRODUCTION

S E L F A S S E S S M E N T G U I D E

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1. What is Cleaner Production?

Cleaner production aims to prevent pollution, reduce the use of energy, water and material resources and minimise waste profitably, all without reducing production capacity.

It involves rethinking conventional methods to achieve 'smarter' products, product components, and production processes.

While casting operations are relatively clean, all casting operations have some potentially harmful to the environment, the health of their employees and to generate nuisance issues in the community. The direct costs of treating and disposing of these wastes can be high and the trend is towards increasing costs for business and for the community. The true cost may be much higher still when the social costs of extracting virgin materials and creating large landfills is taken into account.

Treatment and disposal of waste generally only address the symptoms of an inefficient process. Waste may be an indicator that you are losing money unnecessarily.

Cleaner Production aims to reduce waste and inefficiency at source.

It can save you money!

2. How to Use this Guide

This Self Assessment Guide is designed to help you explore the opportunities for ***Cleaner Production*** in your organisation. This Guide suggests the following five simple steps to implement Cleaner Production in your operation:

- Measure use of chemicals and consumables and measure the waste generated;
- Identify causes of waste generation;
- Identify opportunities to reduce waste;
- Evaluate the viable options; and
- Implement the best options and review the improvements.

The tables and checklists which make up this guide have been provided in a tear out section to assist you in carrying out these steps. Once changes have been implemented you can use the tables again to check your progress.

Many of the commonly recognised areas for reducing waste in the Metal Casting industry are listed in the Guide to get you started. Extra space is provided for you to include information that is specific to your operation and any *Cleaner Production* ideas of your own.

3. The Benefits of Cleaner Production

The major benefits from a Cleaner Production program are:

3.1 Saving Money

Cleaner Production can save you money through better use of your valuable resources. For example, savings can be achieved in the areas of:

- wasted raw materials;

- water and energy consumption;
- waste treatment and disposal.

Cleaner Production strategies typically cost less than treatment and disposal (so called 'end-of-pipe') technologies. Complying with the discharge limits set by Council the through on-site treatment can be a significant cost, may require specialist knowledge and generally provides no profit for the organisation.

Cleaner Production, on the other hand, focuses on improving your core business. Companies can often perform better than their environmental requirements as an outcome of running a profitable and efficient business. Many strategies, such as *housekeeping* and *process improvements*, can be implemented at a low cost and can have ***immediate benefits***. Changes to plant and equipment will require capital but many Cleaner Production projects that have been undertaken show that they can pay for themselves in less than one year.

3.2 Preventing Pollution

Cleaner Production is about preventing pollution, reducing the use of energy, water and material resources and minimising waste, without reducing production capacity.

Businesses are encouraged to review work practices and processes throughout the entire operation to identify ways to reduce waste at the source rather than trying to control pollution at the 'end-of-the-pipe'.

3.3 Complying With Environmental Legislation

Cleaner Production will assist in maintaining or improving compliance with relevant environmental legislation. This can bring a number of benefits such as reduced regulatory intervention, possible reduced licence fees and charges and better control over your business.

Regulations regarding the transport and disposal of wastes are becoming tougher. In Queensland, regulations are being formulated to include waste minimisation and Cleaner Production under the Environment Protection Act 1994 (EPA) so these issues are rapidly becoming a reality for industry.

4. The Impacts of Metal Casting Wastes

Foundries are often perceived as being dirty and environmentally unfriendly. However, most modern foundries are relatively environmentally benign in comparison to other industrial activities in the metal sector (e.g. smelting and metal finishing), and most of the by-products generated by the industry have relatively low impacts. The major issues facing the industry are the large volumes of by-products that are currently being sent to landfill, nuisance odours, and the need to maximise health and safety in the industry.

Sand is the largest by-product generated by volume in this process. Even in operations that undertake a high level of reclamation, some new sand is required to maintain the quality of the sand in the system. As a result some sand is lost from the system. This may be sent to landfill, reclaimed off-site or put to beneficial reuse. Foundry sands from ferrous foundries are not usually considered to be hazardous, typically passing TCLP (toxic characteristic leaching procedure) tests, and can be sent to unlined landfill. Some non-ferrous sands contain high quantities of heavy metal, which requires them to be sent to secured landfill sites. Most of the chemical binder used in core and mould making is burnt off during the pouring process.

Binders in waste sand can become an important issue if large volumes of resin-coated sands are wasted before the pouring stage. Binders and salts can build up to unacceptable levels over many reclamation cycles, so careful monitoring and testing is important.

Baghouse dust from the mould and core shops and from the shotblasting operations is typically the second largest by-product generated by volume in sand casting processes. Sand grains are broken down into fines and dust, particularly after multiple reuse, and this can affect casting quality and also create occupational health and safety issues (e.g. silicosis).

Slag is another significant by-product stream by volume. Flux is a material added to the furnace charge or to the molten metal to remove impurities. Flux unites with impurities to form dross or slag. This rises to the surface of the molten metal, from where it is removed before pouring. When cooled this forms a relatively inert complex glass-like structure which can usually be disposed of in unlined landfill or put to beneficial reuse.

Other solid wastes generated in sand casting operations include:

- refractories (furnace and ladle lining);
- drums;
- spent shot;
- metal swarf and shavings;
- timber pallets and timber from the pattern room;
- general foundry waste including packaging and consumables (e.g. rags, gloves, grinding wheels etc).;
- general office and lunchroom wastes.

Foundries also produce small quantities of liquid by-product streams. The major sources are cutting fluids, hydraulic and other oils, solvents, waste paints and paint sludges, uncured and cured binders and waste catalysts (acids and bases). Water streams are also generated from quenching baths, cooling systems and other minor sources.

Air emissions from the process typically include carbon monoxide, organic compounds, hydrogen sulfide, sulfur dioxide, nitrous oxide, benzene, phenols, and other hazardous air pollutants (HAPs). The actual emissions depend on a number of factors including the type of metal poured, the cleanliness of the charge, the types of binders used and the melting and pouring practices employed. A portion of the metal (around 3%) volatilises during the melting and pouring process. The major environmental issues related to these fugitive emissions are usually those of occupational health within the foundry and nuisance odours outside the foundry (USEPA, 1998).

5. How do I Achieve Cleaner Production?

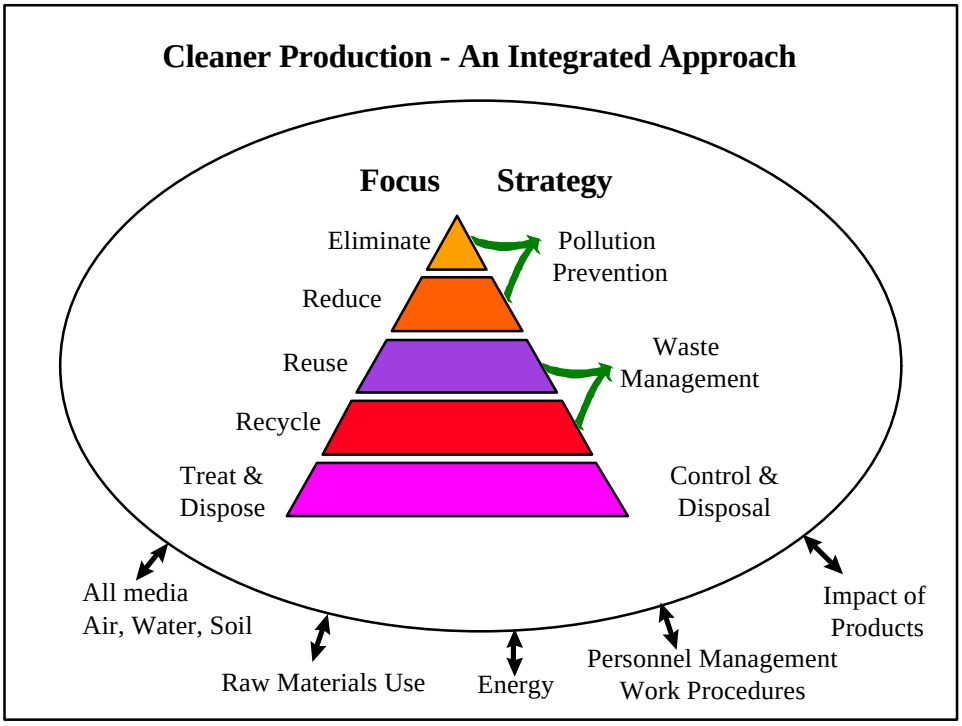
In adopting a Cleaner Production philosophy, try to consider how wastes were created rather than how they can be treated. Record keeping of raw material inputs and outputs, assisted by a monitoring program (perhaps regular audit checks) may help better manage raw materials, and help identify areas where improvements can be made.

Minor improvements in housekeeping and procedures may be all that is required to reduce unnecessary losses of raw materials from leaks and spills. In other cases more significant changes to the process, equipment or layout may be required to achieve improvements.

Considering the Cleaner Production hierarchy helps to focus on options to eliminate or reduce waste at source.

5.1 Eliminate

Elimination the need to use hazardous materials can greatly operating costs and reduce the potential environmental harm. For example, by substituting hazardous materials with less harmful alternatives and standardising the range of chemicals or alloys used.



5.2 Reduce

Where use of certain materials can not be eliminated, try to minimise their use. There are many opportunities to reduce waste and resource use in the foundry. Examples include improving the energy efficiency of furnaces and ancillary services, improving the metal yield in the operation by improving casting design and, improving pouring practices; and reducing sand waste through effective reclamation systems.

5.3 Reuse

There are many opportunities to reuse ‘waste products’ in the metal finishing industry. This will reduce the demand for raw materials and the cost of treatment and disposal. By-product reclamation such as sand, shot and swarf are examples of the opportunities in this area. Some foundries may be able to reclaim heat from the process.

5.4 Recycle

Are the wastes identified by your assessment really ‘wastes’? Can some of these be reclaimed through simple treatment processes that enable them to be reused on-site. Other by-products that cannot be used on site may be able to go off site for recycling or beneficial reuse. In these cases there may be the potential to sell recyclable items and also save indirectly by the avoiding disposal costs.

5.5 Treat and Dispose

This option should only be considered after the other options have been exhausted. Generally these options are typically a cost to industry. However it may be essential to consider this as a part of your overall Cleaner Production strategy.

6. Cleaner Production Assessment Checklists

The first step in developing a Cleaner Production program is to get a good picture of the resources used and the wastes that are generated in your organisation. This will help you to identify the areas that are costing you money and harming the environment and will help you assess the costs and benefits of implementing Cleaner Production options.

This Guide has been designed to help companies meet their requirements under the new Environment Protection Program (EPP) for Waste to develop and implement a Cleaner Production Plan. By undertaking the steps recommended by this Guide companies can help improve their bottom line and their environmental performance.

7. Sources of Information

You will already have access to most of the information you need to carry out your Cleaner Production analysis. This information will help you to calculate the quantity and full cost of your raw materials and wastes including materials, labour, maintenance, cleaning and utilities. Some of the major sources of information will include:

- process descriptions and specifications;
- equipment specifications;
- quality assurance procedures and records;
- purchasing, invoice and inventory records;
- production and scheduling records;
- trade waste agreement and council rates notices;
- cleaning contract records;
- flow meters;
- Materials Safety Data Sheets (MSDS);
- information from suppliers; and
- specific monitoring programs.

In many companies, these systems are designed to account for production and sales - not wastes. Therefore, it may take some work to get a good picture of waste. Are there opportunities to improve these systems to better account for resource use and wastage?

8. Contacts

If you would like any further assistance or information please contact one of the following people:

Name	Organisation	Telephone
Philip Glew	Chair, Cleaner Production Project Steering Group, RMC (Reliance Manufacturing Company) Pty Ltd.	3252 3646
Bob Pagan	UNEP Working Group for Cleaner Production, Queensland University.	3365 1594
Ken McKeon	Queensland EPA - Sustainable Industries Group.	3227 8925
Helen Jentz	The CRC for Waste Minimisation and Pollution Control, Ltd.	3244 1777
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Water Checklist

Water Use	Monthly Use	
	Quantity	Value
Water Used (water in)		
Trade Waste (water out)		
Volume		
BOD_5 or TOC		
Suspended Solids		
Oils and grease		
Total Cost		

Water Application

Appliance	Flow rate (litres/min)	Time in Use (hours)	Daily consumption (litres/day)	Cost per month	Percent of Total	What can we do to reduce?
Domestic use						
Quench tanks						
Cooling towers						

Energy Checklist

Fuels Used	Monthly Use	
	Quantity	Value
Electricity		
Gas		
Coal / coke		
Oil		

Energy Application

Appliance	Time in use (Hours)	Daily consumption (kWh)	Cost per month	Percentage of Total	Action (eliminate, reduce, recycle)
Heaters					
Rectifiers					
Other (Pumps)					
Furnaces					
Heat treatment					

Product Checklist

Resource Type	Raw Materials		Wastes				Total Cost	Rank	
Product*	**Quantity** (kg/month)	**Value**	**Quantity** (kg/month)	**Lost Product Value**	**Treatment / Handling Cost**	**Disposal Cost**	(add values and costs)	**Cost**	**Toxicity**
Metals									
Alloys									
Sand									
Refractory Material									
Furnace lining									
Ladle lining									
Paint									
Consumables									
Sleeves									
Filters									
Solvents									
Oils and emulsions									
Aerosols									
Cleaning solutions									
Other Products									
Oil filters									
Batteries									
Rags									
Packaging									
Paper									

Resource Type	**Raw Materials**		**Wastes**				**Total Cost**	**Rank**	
Product*	**Quantity** (kg/month)	**Value**	**Quantity** (kg/month)	**Lost Product Value**	**Treatment / Handling Cost**	**Disposal Cost**	(add values and costs)	**Cost**	**Toxicity**
Cardboard									
Glass									
Plastic									
Rags									
Empty drums									
Other									

* Note that these are suggestions only - include items that are appropriate to your operation.

Cleaner Production Options

Use this Checklist to help identify options that may be suitable to help address the key problem areas identified in the previous tables. The ideas presented range from simple and inexpensive to complex options. Each is explained further in the manual accompanying this Guide. If a specific option is not relevant to your organisation, you may be able to adapt an idea or principle. Think laterally about your operation, ask 'why' and 'what if' type questions, and you may come up with many more opportunities to profit from Cleaner Production.

CP Option	***Questions***	***Relevance (Tick One)***		
		Not Relevant	Current Practice	Potential Option
Housekeeping	• Is the state of general housekeeping affecting the flow of work or causing spills?			
	• Are materials and chemical supplies being stored appropriately to minimise the risk of damage or waste?			
	• Can just-in-time purchasing practices be implemented to reduce the cost of inventory management and avoid waste from out-of-date materials (e.g. resins, catalysts and paints)?			
	• Can preventive maintenance be use to optimise the efficiency of major equipment and ancillary systems (e.g. furnaces, natural gas leaks etc.)?			
	• Can we improve staff training programs to increase awareness about Cleaner Production or to provide skill that increase operator efficiency?			
	• Can we provide incentives (financial and non-financial) to increase participation in Cleaner Production?			
Alternative inputs	• Can we work with scrap suppliers to improve the quality of the charge material to avoid contamination?			
	• Can we alter the metals and alloys that we use to improve casting quality?			
	• Can we improve our materials testing procedures to improve product quality and reduce waste?			
	• Can we improve sand quality to improve the dimensional accuracy of the cast?			
	• Can we change the type of binders and other additives to improve cast quality, increase reuse options, improve environmental performance etc?			
	• Can we change the type of refractory material used in the process?			
	• Can we change from solvent based coating systems to water-based systems?			
	• Can we alter the pattern or die materials to improve process performance?			

CP Option	*Questions*	*Relevance (Tick One)*		
		Not Relevant	Current Practice	Potential Option
	• Are there any new consumables (e.g. risers, sleeves etc.) that will improve casting efficiency?			
	• Can we change the type of energy used in the process to improve efficiency and environmental performance (e.g. natural gas etc.)?			
Metal yield	• How many tonnes of metal do we melt for each tonne of usable castings? What are the major areas of loss (e.g. melt losses, spilt metal, pigged metal, runners and risers, reject castings, or grinding losses)?			

	• Can any of these areas of metal loss be reduced by:
	  • minimising metal spills, over- or under pours thorough precision pouring techniques?
	  • redesigning the gating system to make it more efficient?
	  • using casting simulation technology to improve cast design and solidification properties?
	  • working with our customers to redesign the casting to reduce it's weight or improve its casting characteristics?
	  • minimising grinding losses or even eliminate some fettling operations from the foundry?
	  • using metal filtering, direct pouring techniques or other methods to minimise inclusions in the metal?			

	• Can we redesign, optimise or change the casting process used to increase the metal yield?			
Energy efficiency	• Have we undertaken a recent detailed assessment of energy efficiency in the foundry?			
	• Can we benefit from implementing an energy monitoring program to manage energy use for either the whole foundry or for major equipment such as furnaces?			
	• Can we optimise the efficiency of our metal melting and holding processes (e.g. · change technology, better insulation, use protective covers over the melt; put a cover on the pouring ladle)?			
	• Can we optimise the efficiency of the ancillary services in the operation?			
	• Can we benefit from investing in automatic energy control systems to shut down equipment when not in use?			
	• Can we develop greater staff awareness of energy efficiency and run an effective 'switch-off' program?			

CP Option	*Questions*	*Relevance (Tick One)*		
		Not Relevant	Current Practice	Potential Option
	• Can we improve the ladles and refractory materials used in the furnaces and to improve energy efficiency?			
	• Can we recover energy from any sources for reuse elsewhere in the foundry?			
	• Can we benefit from investing in energy efficient equipment and up-grading old equipment (e.g. lighting, ladle preheating, sand reclamation, furnaces etc.)?			
Minimising by-products	• Have we calculated the full cost of by-products to the company (including purchasing, processing, disposing and compliance costs)?			
	• Do we effectively segregate our by-product streams to improve internal and external reuse options and reduce the cost of disposal?			
	• Do we have an effective strategy in place to minimise each major waste stream?			
	• Can we improve the casting design process to minimise sand use (e.g. better flask utilisation)?			
	• Are there other areas of the operation we can improve to minimise sand waste (e.g. minimise spills)?			
	• Can we implement computer aided sand mixing systems to minimise sand and binder use?			
	• Do we regularly investigate and trial new binder systems?			
	• Can we improve the efficiency of our sand reclamation system?			
	• Can we minimise other foundry by-products or reduce the demand for consumables?			
	• Once by-products have been minimised as much as possible, are there any beneficial reuse options that minimise the cost of managing the material?			
Production planning and improvement	• Do we have an effective Environmental Management System that is integrated with our other business systems?			
	• Can we improve the layout or streamline the process to improve the efficiency of the operation?			
	• Can we use production simulation technology to help redesign our processes?			
	• Can we utilise any computer aided technologies in the foundry (e.g. rapid prototyping, rapid tooling, casting simulation)?			
	• Can we benefit from undertaking a cost / benefit			

CP Option	*Questions*	*Relevance (Tick One)*		
		Not Relevant	Current Practice	Potential Option
	analyses of different casting systems for part of all of the products or for new markets (e.g. Investment, permanent mould, die, lost foam and vacuum casting)?			
	• Can we develop a capability in another casting process for some of our products (or for new markets)?			
	• Can we improve our communication systems (e.g. electronic data interchange, the Internet) to reduce our lead times, increase the efficiency of the process and offer better customer services?			
	• Can we improve scheduling and materials tracking systems?			
	• Can we develop / improve smart controls and sensors for automatic supervision?			
	• Can we use / improve computer aided design tools to integrate concept design, prototyping, pattern making and moulding?			

Evaluation of Cleaner Production Options

To determine which options are the best for your organisation you will need consider a range of financial and non-financial considerations associated with each.

Financial Considerations

To help determine the company's financial ability to implement each option and its economic viability. Once you have a short list of possible option you can use the following table to evaluate them. Consider:

- the cost and benefits of each option
- the capital investment required; and
- the payback period.

CP Option	Example	Value		
		1) (e.g. Upgrade furnace)	**2)** (e.g. Optimise furnace)	**3)**
Capital Costs	Equipment			
	Installation			
Annual Costs	Maintenance			
	Materials			
Total Costs				
Benefits	Increased Sales			
	Sale of By-products			
	Annual Savings:			
	Materials			
	Water			
	Energy			
	Treatment			
	Disposal			
Total Benefits				
Net Annual Benefits				
Payback Period				

Other Considerations

As well as financial options, you also need to consider how the change will impact on your other systems and the practical implementation issues associated with each option.

Non-Economic Analysis		
Questions	**Notes** **(sources, causes, potential improvements)**	**Likely Impact** **(1-5)**
How will the change affect product quality (positive/negative)? Are any trade-offs acceptable?		
How will the change affect health and safety (positive/negative)?		
What are your customers expectations? Would they care about the change? What changes would they accept or even find desirable?		
What impact will the change have on the environmental performance of the company (i.e. reduce the toxicity or impact of wastes, reduce environmental liability etc.)?		
What are the requirements of people in different departments (i.e. purchasing, cleaning, production, maintenance)? What is the best compromise solution?		
How easy will it be to implement the change? How much time, and expertise will be needed? Are these resources readily available?		