Skills for Sustainability

Manufacturing Skills Australia

Sustainability issues in metal casting & forging

This project is supported by the Australian Government
through the Clean Sustainable Skills Package

Contents

Skills for Sustainability | MSA Manufacturing Skills Australia

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August 2012

About the guide

This guide presents an outline of the social, economic and environmental sustainability issues that typically arise in the metal casting and forging sector. It focuses on the manufacture of iron, steel, copper and aluminium products through the processes of casting and forging.

Casting involves melting metal and pouring it into a mould. Moulds are typically made from sand and a binding agent. A core can be used within a mould to make internal shapes or voids.

Forging uses compression to shape the metal. Depending on product specifications this might be done at 'cold', 'warm' or 'hot' temperatures. These are relative terms – cold forging may include heating the metal but to a lesser temperature than warm or hot forging. Forging might be done using hand tools (like a blacksmith) or machinery to press or hammer the metal and dies to control the shapes.

Examples of products include:

- Automotive parts
- Transport (e.g. rail, ships, mining and construction)
- Heavy equipment and machinery (e.g. agriculture, manufacturing, mining and construction)
- Machine tools and parts
- Lifting and material handling equipment
- Water, sewerage and drainage pipes.

The guide shows some of the processes that are common across the sector and how sustainability issues relate to different parts of the process. These issues will vary depending on the inputs and activities in each process step.

The guide will assist Registered Training Organisations (RTOs) to identify the sustainability issues in a sector and/or business. It provides a high-level snapshot of sustainability in the sector. This can be used as a basis for the RTO to undertake its own research in order to:

- Consult with clients and understand their business and skill needs
- Develop their training and assessment strategy
- Contextualise training and assessment materials and activities.

The guide is not intended as learning material for students, however, it may be useful as part of a suite of information resources. It may also provide a model which a RTO can adapt, expand and/or contextualise for use in its own materials.

The Skills for Sustainability website provides further support for RTOs, including links to more information about this sector and guides to identifying the sustainability issues in five other manufacturing sectors. See http://www.sustainabilityskills.net.au.

What is in the guide?

The guide includes:

- An overview of sustainability issues
- Simple process flows
- A risk rating table for sustainability issues at various points in the processes
- Examples of possible *high impact* issues and their causes.

The guide provides a 'map' of where sustainability issues are likely to arise in a particular manufacturing process, and what the impact of these issues might be. It uses a risk rating system and explains the potentially *high impact* issues in more detail. Brief and simplified examples are provided, which do not cover all of the possible sustainability issues and variables within the sector.

The process steps and sustainability issues in the sector have been identified through discussions with stakeholders and desktop research. Sources include IBIS World Industry Research Reports, International Finance Corporation (IFC) Environmental Health Guidelines, the MSA Environmental Scan 2012 and the National Pollutant Inventory Emission Estimation Technique (EET) Manuals.

Overview of sustainability issues

This section provides an overview of sustainability issues that are likely to affect enterprises in the metal casting and forging sector.

Sustainability issues	
Economic sustainability	• Low profit margins and high cost of capital – limits ability to invest in new technology and training, particularly for small businesses. • High electricity usage – a high and growing cost, generates greenhouse gas (GHG) emissions, exposure to the Carbon Price, and possible future threats to electricity supply due to finite fossil fuels. • Labour intensive industry – exposure to high labour costs and risk of industrial action. • High freight costs – limits exposure to global markets and creates reliance on local markets. • Local market volatility – heavy reliance on the automotive sector which is in decline, and on the mining industry, which is heavily impacted by commodity markets. • Fluctuating commodity markets – impacts both the supply chain (raw materials) and markets (mining sector). • Innovation is the key to future productivity – requires changes to the workforce and technology, both of which are costly.
Environmental sustainability	• High energy usage to operate furnaces (mainly coke or electricity) and machinery – generates significant carbon emissions and relies on non-renewable resources. • High use of fuels in supply and distribution – non-renewable resources. • High use of metals as raw materials – non-renewable resources. • Supply chain activities, such as mining of fuel, coal, minerals and ores, and use of fuels for transport – may damage land and water, affect air quality, and disrupt communities and local flora and fauna. • Toxic chemicals and other substances used or released during production may release GHGs, volatile organic compounds (VOCs) and other emissions with may affect land, air and water quality. • Water is used in cooling systems for furnace and moulds and as a cleaner and dust suppressant. • Non-degradable waste from production and end-of-product life – chemical, plastic and metal waste may contaminate land, water and air if not captured or recycled. • Sand is a significant waste from some casting processes but is not typically recycled.
Social sustainability	• Technology developments may lead to redundancies for lower skilled workers and/or require significant re-training of existing staff. • Workplace health and safety issues are significant given the level of heat, chemicals and, in smaller businesses, the manual nature of the work. • Impacts on local communities of emissions, waste, visual amenity, noise and traffic entering and leaving the site.

Process flows

This section provides two simple process flows showing some common steps in metal casting (Figure 1) and forging (Figure 2). They provide a broad indication of the inputs (such as materials, energy, labour and equipment) and outputs (such as GHG emissions, particulates, waste materials and products). This defines a focus area so that specific sustainability interactions can be identified.

Value chain issues

This process flows focus on a 'gate to gate' section of metals manufacture by casting and forging.

While they are not the focus of this process flow, the supply of raw materials and distribution of products can contribute significant sustainability impacts to the value chain and businesses can have some influence over them. For example, many enterprises include environmental and social sustainability criteria in tenders and contracts.

Other parts of the value chain that are excluded from this production-focused flow can influence the mix of sustainability issues that are identified. For example, the flow could include management or customer service processes. This would be likely to show more social sustainability issues in areas such as governance, ethics or customer complaints.

For more information about sustainability in practice and sustainable supply chain see http://www.sustainabilityskills.net.au.

Moulds	Molten metals	Casting	Finishing
•INPUTS •Design •Sand or metal moulds •Cores and patterns, if used • Binders (e.g. chemicals, resins, catalysts and clay) • Release agents •Labour •OUTPUTS •Template •Wastewater •Waste binders and release agents •Dust •Emissions to air (e.g. GHGs and VOCs)	•INPUTS •Metals •Energy to heat furnaces (e.g. coke, diesel, electricity and gas) •Electricity to run machinery and extraction fans •Labour •OUTPUTS •Heat •Molten metal •Waste (slag) •Emissions to air (e.g. gaseous metals, GHGs, CO, SO_x, NO_x and VOCs)	•INPUTS •Moulds and cores •Molten metal •Electricity to run machinery and extraction fans •Labour •Water •OUTPUTS •Wastewater •Dust •Emissions to air (e.g. gaseous metals, GHGs, CO, SO_x, NO_x and VOCs) •Cast product (in moulds)	•INPUTS •Cast product •Electricity to run 'shake out' and cleaning equipment (e.g. vibration, shotblasting, welding, grinding and cutting) and extraction fans •Labour •OUTPUTS •Finished product •Wastewater •Used sand, moulds and cores • Metal particulates

Figure 1: Metal casting process flow

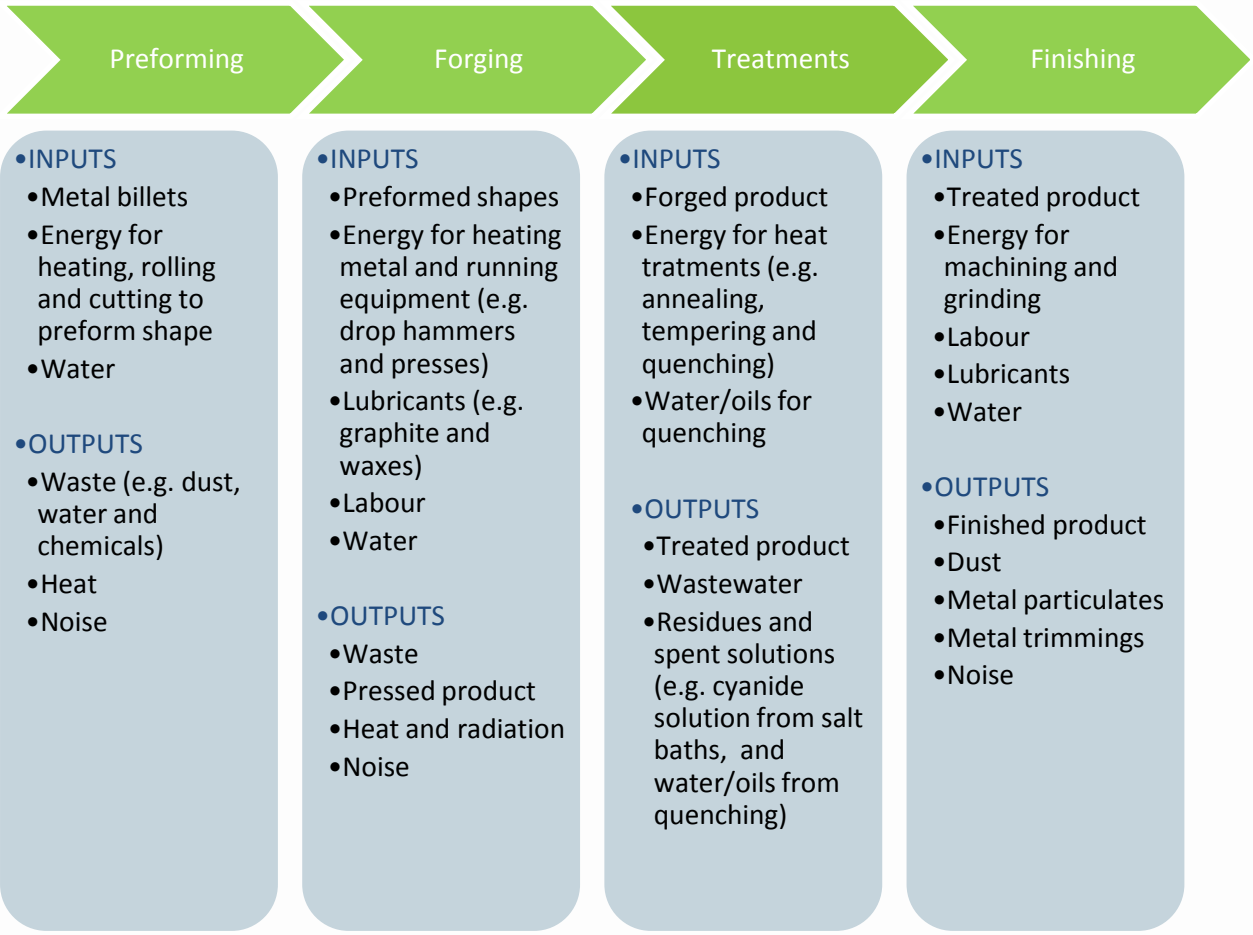

Figure 2: Metal forging process flow

Risk rating of sustainability issues in the process flows

This section looks at each step in the process flows (above). Typically, each step in a process will apply different techniques, use a range of equipment and require various inputs. These can result in very different sustainability issues at each step. This risk assessment investigates the risk of a particular sustainability issue occurring at each step and estimates the potential level of impact.

Risk assessments are subjective and require interpretation of information. In this instance the risk assessment will also depend on local and enterprise variables, for example, physical location, management systems, the economy, the skill level of the workforce, external events and available technologies.

This risk assessment is against a number of issues within economic, social and environmental sustainability. This list of issues is not exhaustive and there are many different ways that sustainability issues can be described and categorised. This list draws on a number of sources, including the Global Reporting Initiative (GRI), ISO 14001 Environmental management systems, ISO 26000 Guidance on social responsibility and the Skills for Sustainability website.

The risks have been rated using a scale for **likelihood** (probability) and **impact** (consequence).

Likelihood – the probability of occurrence	Impact – the consequences of occurrence
H = highly likely	H = high impact
M= might happen	M = moderate impact
L = less likely	L = limited impact

In the following table the probability is listed first followed by the likely level of impact. So ‘H/M’ would be highly likely to happen and, if it did happen, would be expected to have moderate impact. *High impact* risks are discussed in further detail, as an example. However, this does not imply that other risks do not need to be considered in analysing the sector or in delivering training and assessment.

Metal casting and forging risk rating table

Sustainability issues	**Process flow elements and sustainability risks** (Metal casting and forging)			
Economic	**Moulds or Pre-forming**	**Molten metals or Forging**	**Casting or Treatments**	**Finishing**
Political/economic • AUD (exchange rate) • Cost of capital and taxes (including Carbon Price) • Competition with developing countries	M/M	**H/H**	L/L	
	• The impact of the Carbon Price on mining and fuel in the supply chain will flow through to raw materials and transport costs, and is a significant liability. • Growth of developing country suppliers as competitors – with lower costs of labour, tax and compliance these countries compete for local and global customers. • High cost of distribution due to weight of products and distance from global markets limits expansion into global markets. • High AUD exchange rate also limits exporting opportunities.			
Markets • Global and local	L/L			
	• Demand is predominantly local and largely driven by mining, agriculture and the automotive sector.			
Value • Costs and financial risks • Value add and intellectual property • Efficiency	M/M	**H/H**		M/M
	• High cost of energy for heat processes. • Threat to future energy supply due to expected fossil fuel shortages. • Exposure to increased electricity costs due to Carbon Price. • Low profit margins limit the ability to invest in new technologies which could reduce operating costs (e.g. co-generation power management).			

Metal Casting & Forging

Sustainability issues	Process flow elements and sustainability risks (Metal, casting and forging)			
Environmental	**Moulds or Pre-forming**	**Molten metals or Forging**	**Casting or Treatments**	**Finishing**
Materials (and packaging) • Consumption/reduction • Source – recycled/renewable	**H/H**		L/L	
	• Use of non-renewable resources (minerals and ores) to produce raw metals. • Use of sand in casting moulds, typically not recycled.			
Energy and fuels • Consumption/reduction • Source – renewable/non-renewable	M/M	**H/H**		M/M
	• Machinery and equipment powered by electricity, typically generated from fossil fuels (coal). • Petrol and diesel (non-renewable resources) are used extensively in the transport of materials and products in the supply chain. • Furnaces are typically powered by combustion (coke), gas or electricity.			
Water • Consumption/reduction • Source – captured, recycled and potable • Impact on local waterways	M/M		**H/H**	
	• Use of water as a coolant and dust suppressant, typically not from captured or recycled water sources. • Risk of contaminated water run-off to local waterways.			
Emissions, effluent and waste • GHG and ozone depleting emissions • Trade and solid waste • Toxins and hazardous substances	**H/H**			
	• Hazardous substances used as lubricants, binders, release agents, cutting agents and in heat treatments may contaminate air, water and soil (e.g. heavy metals, cyanide and other salts, resins and solvents). • Emissions can include gaseous metals, metal dust, GHGs, VOCs, NOx, SOx and CO. • Solid waste (e.g. metal trimmings and flash, and sand from moulds) which may go to landfill instead of being recycled. • GHG emissions and pollutants from transport in the supply/distribution network.			

Sustainability issues	**Process flow elements and sustainability risks** (Metal casting and forging)			
Habitat • Risk management and mitigation • Vulnerable area impacts	L/L	**M/H**		L/L
	• Local habitats may have particular vulnerabilities to the materials, substances and processes used (e.g. drawing water from limited local supply, and impact of metal dust or heat on flora and fauna). • Supply chain activities (e.g. mining of fuel, coal, minerals and ores and use of fuels for transport) may damage land and water, affect air quality, and disrupt communities and local flora and fauna.			
Social	**Moulds or Pre-forming**	**Molten metals or Forging**	**Casting or Treatments**	**Finishing**
Worker health and safety • Operation of heavy machinery • Handling of heavy, hot or hazardous materials • Safety training, equipment handling and drills	M/M	**H/H**		M/M
	• Worker exposure to heat, noise, dust, chemicals, gases and pollutants can cause serious health issues. • Operation of heavy equipment requires specialised training and monitoring. • Handling of hazardous and/or hot materials requires specialised training and monitoring.			
Workplace culture and workforce development • Worker engagement, job design and working conditions • Diversity and equal opportunity • Training and development	**H/H**			
	• Forging and casting are labour intensive sectors, with relatively out-dated technology. • Technology developments may lead to redundancies for lower skilled workers. • Managed redundancy and transition processes may be required. • Training for existing workers and recruitment of skilled workers may be required.			

Sustainability issues	**Process flow elements and sustainability risks** (Metal casting and forging)			
Social	**Moulds or Pre-forming**	**Molten metals or Forging**	**Casting or Treatments**	**Finishing**
Heritage and amenity • Cultural heritage • Visual amenity, noise and pollution from plant/site • Impact on pedestrian movement and resident privacy • Traffic entering and leaving the plant (e.g. noise, pollution and hazards)	M/M			
	• Heat and noise from casting and forging may generate complaints from locals despite meeting environmental requirements. • The delivery of supplies or the distribution of finished product may generate traffic and associated pollution and emissions. This can have a detrimental effect on community amenity and lead to complaints and poor reputation in the local community.			
Community • Engagement • Local programs • Complaints	M/M			
	• Casting and forging businesses may have a poor reputation (seen as dirty, noisy, heavy industries). This may lead to difficulties in recruitment, complaints from locals or community action or pressure to leave the area.			
Ethical practice • Governance and compliance • Management of contracts and transactions • Treatment of workers, suppliers, customers, competitors, locals and Indigenous persons	L/L			
	• The risk of collusion or unethical practice in supply chain contracts, which may cost the business through fines and/or negative media coverage. • Poor practices in the supply chain may generate negative media coverage. • Effective management of these issues requires staff training and monitoring processes.			

Sustainability issues	Process flow elements and sustainability risks (Metal casting and forging)			
Social	**Moulds or Pre-forming**	**Molten metals or Forging**	**Casting or Treatments**	**Finishing**
Product responsibility • Safety and sustainability of products • Labelling, stewardship and transparency • Ethical marketing	**M/H** • Product safety – poor quality practices and/or materials in any step in the process can affect the safety of products. • Incorrect or inadequate labelling or product information may result in significant safety breaches/accidents. • Effective management of these issues requires systems and procedures, staff training and monitoring processes.			