



# International Stainless Steel Forum 2012 Sustainability Award Case Studies

**SUSTAINABLE**  
**STAINLESS**

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# Welcome from the Chairman of the ISSF Health and Environment Committee



The International Stainless Steel Forum's (ISSF) Sustainability Award recognises the outstanding contributions of our member companies to the sustainability of the stainless steel industry. This is the second year that the Award has been presented, and I am pleased to see that so many companies have taken the opportunity to detail their sustainability initiatives.

The 2011 edition of the Award attracted 17 entries from 11 of ISSF's member companies. This year the number of entries has more than doubled to 36, and 15 companies are taking part. In 2012 the list of categories has also been expanded to include projects which add value for customers.

The 2011 Sustainability Award was won by Outokumpu for its Reducing Waste to Landfill project. The three-year project saw Outokumpu's Sheffield melt shop (SMAC) reduce the waste it sent for disposal by 44%.

The reduction has been possible thanks to Outokumpu's efforts to recover and reuse by-products from the steelmaking process. Since 2007, over 80% of all slag produced has been recovered and re-used as road stone in the production of asphalt. During 2010, half of all refractory waste generated on site was re-used as a lime substitute.

The recovery and re-use of waste materials is a common theme in the entries for the 2012 ISSF Sustainability Award. As well as reducing the amount of material sent to landfill, new markets are being found for waste materials. This turns a costly problem into a revenue generator for the business and has a positive impact on the environment. In other examples, waste materials are being recovered, treated and reused in the stainless steelmaking process.

In 2011, I expressed the hope that the ISSF Sustainability Award would inspire other companies – both up and down the stainless steel value chain – to improve their sustainability performance. A doubling in the number of entries, might indicate that message has been heard. Yet there is still much more work to be done and I look forward to reading the contributions to our next Award in 2013!

David Martin

Chairman, ISSF Health and Environment Committee

# Secretary General's Message



During 2012, the world stainless steel industry is celebrating a century since stainless steel was first discovered and commercialised. In those 100 years, the industry has grown rapidly and the range of products expanded dramatically.

But with our success has come responsibility. For many decades the stainless steel industry has been acutely aware of the need to operate in a sustainable way. But we have also been aware that sustainability is about more than just respect for the environment.

For the members of ISSF, it also means respecting the people who work in the industry by providing them with safe working conditions. Sustainability is also about creating profitable businesses which generate employment and income for the communities in which they are located. By achieving this, we can support the many people and businesses who rely on the stainless steel industry to provide them with this unique material.

The ISSF Sustainability Award is a reminder that we must continually focus on all three pillars of

sustainability: People, Profit and Planet. In these case studies for the 2012 Award, you will read some of the many contributions ISSF's members are making in these areas.

This year we have added a new category to the Award – Value to Customers. This category recognises the importance of our downstream customers, without whom there would be no need for stainless steel.

The winners of ISSF's 2012 Sustainability Award will be announced during our Annual Conference to be held in Beijing during May. However, I would like to take this opportunity to acknowledge the contribution all members of ISSF are making to sustainability. Only by succeeding in those efforts will we create an industry that can survive, and thrive, for another century of innovation.

Pascal Payet-Gaspard

Secretary General, International Stainless Steel Forum

# Summary of Case Studies

All ISSF member companies were invited to submit entries for the 2012 Sustainability Award. Fifteen companies submitted a total of 36 entries. These members operate stainless steel plants in Africa, Asia, Europe, and South America.

Members were asked to choose a category that best described their entry. In many cases, multiple categories were selected.

The following table summarises the entries received.

	Company	Case Study	Employee training	Energy intensity	Environmental management systems (EMS)	Greenhouse gas (GHG) emissions	New processes & products	Material efficiency	Safety	Value to customers
01	Acerinox	Energy efficiency improvements								
02		Fire-resistant oil recovery								
03	Aperam	Added-value residue								
04		Healthy and Safety day								
05		SolarStyl®: New building-integrated photovoltaic system								
06	Baosteel	Cold rolling mill improvements lead to better products								
07	Columbus Stainless	Calcium nitrate recovery								
08	JFE Steel	Safety improvement during roll-change operation								
09	Jindal Stainless Ltd.	An integrated & result-oriented approach to sustainable EMS								
10		Energy sustainability: Energy saved is energy generated								
11		Induction training programme for graduate engineers								
12		Instilling a positive safety culture								
13		Pickling acid management – more than just recovery								
14		Scientific competency mapping								
15		Training on hydraulics								

	<b>Company</b>	<b>Case Study</b>	<i>Employee training</i>	<i>Energy intensity</i>	<i>Environmental management systems (EMS)</i>	<i>Greenhouse gas (GHG) emissions</i>	<i>New processes &amp; products</i>	<i>Material efficiency</i>	<i>Safety</i>	<i>Value to customers</i>
16	Nippon Metal Industry	Development of a low nickel austenitic stainless steel								
17		Improvement in recycling performance								
18	Nippon Yakin Industry	Round-dot patterned stainless steel plate is easy to clean								
19	Nisshin Steel	Modified ferritic grade developed for hot water application								
20	NAS	Slag dust control								
21	Outokumpu	Continuous improvement in energy efficiency								
22		ECO-EPD's answer green building scheme requirements								
23		Light duplex road tankers reduce emissions and increase payload								
24	POSCO	Providing a complete customer solution								
25		Reducing acid consumption								
26	SAIL	Training leads to the successful commissioning of a melt shop								
27	TISCO	Growing stainless steel production in an urban area								
28		High efficiency utilisation of remaining heat								
29	YUSCO	Improvement in compressor efficiency								
30		On-the-job training for employees								
31		Fuel substitution reduces CO <sub>2</sub> from steam system								
32		Industry & university cooperation to increase stainless steel use								
33		Modifications to the gravity dust separator in the converter								
34		Improvements in slag recycling								
35		First Taiwanese certification of stainless steel's carbon footprint								
36		Improvement in safety protection								

# What Makes Stainless Steel a Sustainable Material?

Before we can determine whether stainless steel is a sustainable material, we should first define what we mean by sustainability in relation to what is known as the triple bottom line: People, Planet and Profit.

## People

The material, in its use or in its production process, respects the human being, especially in terms of health and safety. A sustainable material does not harm the people working to produce it, or the people who handle it during its use, recycling and ultimate disposal.

Stainless steel is not harmful to people during either its production or use. A protective layer forms naturally on all stainless steels because of the inclusion of chromium. The passive layer protects the steel from corrosion – ensuring a long life. As long as the correct grade of stainless is selected for an application, the steel remains inert and harmless to the people who handle it and the environment.

These characteristics have made stainless steel the primary material in medical, food processing, household and catering applications.

## Planet

The emission footprints of the material, especially those related to carbon, water and air, are minimised. Reuse and recyclability are at high levels. The material has low maintenance costs and a long life, both key indicators that the impact of the material on the planet is at the lowest levels possible.

The electric arc furnace (EAF), the main process used to make stainless steels, is extremely efficient. An EAF has a low impact on the environment in terms of both CO<sub>2</sub> and other emissions. The EAF is also extremely efficient at processing scrap stainless, ensuring that new stainless steel has an average recycled content of more than 60%.

Stainless steels are easily recycled to produce more stainless steels and this process can be carried on

indefinitely. It is estimated that about 80% of stainless steels are recycled at the end of their life. As stainless steel has a high intrinsic value, it is collected and recycled without any economic incentives from the public purse.

## Profit

The industries producing the material show long-term sustainability and growth, provide excellent reliability and quality for their customers, and ensure a solid and reliable supply-chain to the end consumer.

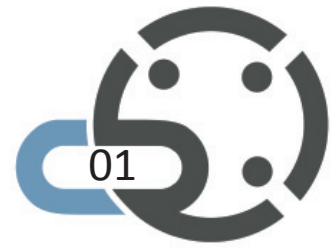
Choosing stainless steel for an application ensures that it will have low maintenance costs, a long life and be easy to recycle at the end of that life. This makes stainless an economical choice in consumer durables (such as refrigerators and washing machines) and in capital goods applications (such as transportation, chemical and process applications).

Stainless steels also have better mechanical properties than most metals. Its fire and corrosion resistance make stainless a good choice in transportation, building or public works such as railways, subways, tunnels and bridges. These properties, together with stainless steels' mechanical behaviour, are of prime importance in these applications to ensure human beings are protected and maintenance costs are kept low.

Stainless also has an aesthetically pleasing appearance, making it the material of choice in demanding architectural and design projects.

Taking into account its recyclability, reuse, long life, low maintenance and product safety, the emissions from the production and use of stainless steels are minimal when compared to any other alternative material. A detailed and precise analysis of the sustainability of stainless steel makes the choice of stainless a logical one. This might explain why, as society and governments are becoming more conscious of environmental and economic factors, the growth in the use of stainless steel has been the highest of any material in the world.





Acerinox

# Energy efficiency improvements

Energy intensity

Greenhouse gas emissions

New processes & products

## Challenge

In 2005, Acerinox introduced a plan to reduce CO<sub>2</sub> emissions. The project required us to undertake a continuous study of our processes and to implement the best available techniques. As direct emissions mainly originate from the intensive use of fuel, our main actions were focused on the reduction of natural gas consumption.

## Action

Our first investment was in heat recovery boilers. One was installed to recover heat from the pre-heating furnace of the hot rolling mill, while another was installed to recover heat from the annealing furnace of the cold rolling mill.

In the recovery boilers, heat from the exhaust gases from these furnaces is used to produce steam which is returned as heat to the process.

## Outcome

The need for steam from conventional gas-fired boilers is reduced, minimising our natural gas use. Installing the heat recovery boilers has achieved cost-savings as less natural gas needs to be purchased. However, the major gain has been a 6% reduction in total emissions.

This improvement in energy efficiency reflects the commitment of Acerinox's Board to improve the company's environmental performance.



Acerinox

## Fire-resistant oil recovery

Material efficiency

New processes & products

### Challenge

Waste generation may be one of the main environmental impacts of any industrial activity. Recovering and reusing wastes at every opportunity minimises this impact. The steel industry has already been quite successful at implementing processes to recover wastes such as metals and acids produced during steelmaking.

Acerinox has continued to looking for new ways to recover waste material. The latest initiative from the Environmental Committee is a process to recover used oil from cold rolling lines.

## Action

The project is focused on the recovery of fire-resistant oils from the annealing and pickling lines. During the project, the following actions have been taken:

- The area fused for the extraction and storage of used oil has been improved.
- Investments have been made in the equipment required to collect and process the oils.
- Analysis of the recovered oil is performed to check its quality before it is reused.

## Outcome

Used fire-resistant oil has been extracted from the cold rolling lines successfully and none is disposed of as waste. New fire-resistant oil consumption has dropped by 74% resulting in significant cost savings.

The results have been welcomed by Acerinox's Environmental Committee. The project has been such a positive experience, that new lines of treatment are now under consideration and the recovery of other types of oils will be the subject of future studies.



Aperam

## Added-value residue

Energy intensity

Material efficiency

Value to customers

### Challenge

The Wastewater Treatment Plant (WWTP) of Aperam's Timoteo plant in Brazil generates an average of 2,100 tonnes of sludge each month. This represents around 17 kg of waste per tonne of steel produced. Sludge represents the biggest volume of waste generated by the plant.

## Action

Before exploring possible applications for the material, we first made a careful analysis of the material using chemical analysis, electron microscopy scanning, and X-ray diffraction. The aim was to identify whether heavy metals were present in the mud and at what percentages.

Initially, the idea was to find a way of reusing the material in the steelplant. However, the high concentrations of phosphorus and sulphur in the sludge made this solution technically impossible.

Based on the results of the chemical evaluation, we started looking for possible applications in the ceramic industry. We started by characterising the waste according to Brazilian Standard NBR 10.004/2004. This showed the sludge was non-hazardous and an inert material.

After identifying an interested ceramics company, we made an analysis of the suitability of the clay as a raw material for the production of bricks, also according to NBR 10.004. This also resulted in the material being characterised as non-hazardous and inert.

As part of the test, a part of the dried sludge was mixed with the clay in proportions of 5, 10, 15 and 20%. After the sample bricks were produced, they were sent for analysis according to the NBR 10.004. The results indicated the bricks were non-hazardous and inert materials.

In tests of their physical endurance, the bricks met industry standards and showed a strength gain of around 50%. This exceeded the strength of bricks made only from regular clay.

## Outcome

A material that was previously treated as waste was made available to the ceramic industry. After extensive testing, this waste product became a raw material for the production of bricks in the ceramic industry.

The ceramic industry is able to reduce its use of clay, a finite natural resource, and replace it with a by-product generated during the production of stainless steel.

We are already providing the recovered material to one client in the ceramic industry. The next step will be to commercialise the process and offer the material to other companies. In this way, a market will be created for all of the sludge generated in the plant.

As an additional benefit, the waste yard at Aperam Timoteo will have a longer life cycle.



Aperam

## Health and Safety day

Employee training

Safety

### Challenge

Our challenge was also to hold our first group-wide Health and Safety Day in order to introduce our global workforce to our zero-accident culture. As a new company, we wanted to engage and motivate our employees through this active awareness-raising event. The aim was to develop a safety culture which is embraced at every Aperam site and to transform our workplace into the safest workplace in the industry.

## Action

Prior to the actual event, Aperam's Health and Safety (H&S) Committee prepared a programme of events for the day. The H&S Committee developed standards, exchanges of good practices, guidelines and a H&S roadmap for 2011.

Some of the actions planned for the actual Day included re-examining safety procedures, an exchange of good practices on fair play roll-out, thinking before acting, safety for newcomers, and many more.

The main driver of Aperam's H&S Committee is our belief in proximity management. The following principles guide our actions:

- All injuries and work related illness can and must be prevented.
- Management is directly accountable for health and safety performance.
- Communication to employees and involving them in training is essential.
- Everybody has a role to play in preventing injuries and illness.
- Excellence in health and safety supports excellent business results.

- Health and safety must be integrated into our business management processes.

Using these drivers, each site was able to prepare activities that would build on, and enhance our safety culture.

Members of Aperam's Management Committee, Board Members and all leaders have taken part in the actions.

## Outcome

Health and Safety Day took place on 28 April 2011. Out of hundreds of activities, key highlights included:

- In some locations, up to 100% of employees participated in the event. This was the case in Rodange, Imhua, Barranquilla, Ibérica and Detroit.
- Many constructive safety related exchanges took place between production and administrative employees.
- Senior management visited several plants across the Group. In addition to their participation in the activities with the local teams, they also carried out shop-floor safety audits.
- Subcontractors took part in the event and workshops were run in cooperation with them at many sites.
- In Timoteo, Gueugnon and Chatelet, local authorities and neighbourhood committees participated in the activities and even organised stands.

During 2011, Aperam's Health and Safety performance improved notably. Our lost-time accident (LTA) frequency rate for employees and contractors dropped

to 0.7 per million worked hours. This represents an improvement of 65% compared to 2010 figures.

This improvement was achieved without resorting to restricted work (RW). The RW frequency rate has also improved by 35% compared to 2010.

Aperam's H&S Committee is currently preparing the 2012 edition of our Health and Safety Day.





Aperam

# SolarStyl<sup>®</sup>: New building-integrated photovoltaic system

Greenhouse gas emissions   Material efficiency

New processes & products   Value to customers

## Challenge

Today, building-integrated photovoltaic (BIPV) installations mostly utilise aluminium in structural components. However, aluminium has very poor guarantees regarding mechanical and electrical safety. Aperam wanted to create a new stainless steel product for this application and increase the amount of green energy generated by the photovoltaic system.

The new system also had to:

- Simplify the design of photovoltaic roofs and facades.
- Reduce the installation cost of BIPV modules
- Ensure the water and air tightness of the entire photovoltaic structure
- Provide better mechanical resistance
- Offer a wider range of colours and finishes for the frame and its fittings.
- Provide easy installation and fast mounting.
- Make hot air recovery possible.
- Be adaptable to any kind of BIPV module.

## Action

In partnership with two companies which specialise in photovoltaic technology, Aperam has developed a system of stainless steel parts, plastic parts and electrical connectors. Known as SolarStyl<sup>®</sup>, the system frames the photovoltaic module during its manufacture and reduces the time and cost of incorporating photovoltaic modules on a building's roof or facade.

SolarStyl<sup>®</sup> consists of:

- A frame for PV modules which is made from a thin folded stainless steel sheet.
- A hollowed frame which integrates the wiring and connectors and complies with international standards.
- Electrical plug and play technology.
- BIPV modules which are easy to mount and are automatically interconnected.
- A clip fixing system to keep the BIPV modules in place.

The system provides excellent mechanical performance and can bear static pressure and depression up to 5400 Pa. Aperam can supply the frame and its fittings in a wide range of colours.

The same design can also be used for solar thermal panels, glass panels and roof windows.

## Outcome

SolarStyl<sup>®</sup> is the only BIPV steel solution on the market. It is an innovative stainless steel system with remarkable performance and very good aesthetics. An innovative connector system simplifies the connections between the BIPV modules on the roof or on the facades of the building. To date, 2,000 SolarStyl<sup>®</sup> modules have been installed in France.

By decreasing the cost of the photovoltaic modules and increasing their performance, Aperam is promoting the use of photovoltaic energy and contributing to the development of renewable energy.

The parts and connectors can be used by any photovoltaic system manufacturer. They are adaptable to the different types of photovoltaic laminates available on the market. The parts can also be used to frame thermal modules or glass roofs.

An assembly kit of rails and sleepers allows faster incorporation of BIPV modules on buildings. The kit is adaptable to different types of photovoltaic modules.

Several companies have already obtained licences to produce and install SolarStyl<sup>®</sup> structures. A consortium, led by Aperam Alloys, has developed a robotic system which can produce SolarStyl<sup>®</sup> frames on an industrial

scale. Operated by a French company, the new production line will be able to frame 100,000 BIPV modules each year.

Aperam and its partners are currently examining how SolarStyl<sup>®</sup> can be applied to other building-integrated systems such as green roofs, or thermal solar hot water applications. This system is adaptable to many different applications and is particularly suitable for aesthetic projects in both public buildings and individual homes.

Aperam Alloys is applying for international certification in order to create a new standard for the SolarStyl<sup>®</sup> BIPV system.

The global market for BIPV is estimated to be more than 50 million square meters per year. SolarStyl<sup>®</sup> aims to corner a significant share of this market.



Baosteel Stainless Steel Co., Ltd.

## Cold rolling mill improvements lead to better products

New processes & products

### Challenge

Baosteel's tandem cold rolling mill (TCM) is faster than the company's Sendzimir mill and has a higher yield. However, it is difficult to control the profile during processing.

As emulsion is used as a lubricant instead of traditional rolling oil, it is more likely to cause scratch defects on the strip surface if improperly used. This reduces surface quality.

## Action

To solve the problem, the following actions have been taken:

- The ingredients in the emulsion have been optimised.
- The cold rolling process has been optimised.
- The material design of the rollers has been changed.

## Outcome

Stable batch production of ferritic stainless steels for automotive exhaust systems has been realised.

Compared to the Sendzimir mill, the TCM is more efficient and consumes less energy. At the same time, yield is enhanced.

The surface quality and properties of the product now meet standard requirements and have been well-received by our customers.

The technology has also been successfully transferred to the production of other super-pure ferritic stainless steels.



## Columbus Stainless

# Calcium nitrate recovery

Material efficiency

### Challenge

After pickling, acid effluents are neutralised and metals are removed, the filtrate still contains dissolved salts, primarily calcium nitrate. Normally this substance is disposed of as waste.

## Action

The filtrate is concentrated by evaporating the water. The resulting concentrated calcium nitrate solution is a marketable product.

## Outcome

The calcium nitrate solution is sold to the explosives industry where it is used as feedstock in the manufacture of explosives.



JFE Steel

# Safety improvement during roll change operation

Safety

## Challenge

Roll changes on the looper had to be done manually because the looper is positioned under the pickling tank, while the crane is above the tank. As the space was narrow and poorly lit, the work was both dangerous and inefficient.

## Action

To improve the operation, JFE developed a carriage for use during the roll change. The carriage can be easily assembled and disassembled at the deck of the pickling tank.

*The new roll-change equipment*



## Outcome

The installation of the new roll changing equipment has led to significant safety and efficiency improvements including:

- Roll balancing and dangerous manual operations have been eradicated.
- The removal of these dangers has changed the risk level for this operation from level 3 to level 1.
- The time taken to change all five rolls on the looper dropped from six hours to two hours and forty minutes.





Jindal Stainless Ltd.

# An integrated and result-oriented approach to sustainable environmental management systems

EMS

## Challenge

The transition to a stable and optimised stainless steel manufacturing facility creates its own set of challenges. In order to instil a culture of sustainability and value-adding amongst our young plant engineers, Jindal Stainless sought to implement the following strategies:

- Promote Proactive Sustainability in all environmental management system (EMS) functions such as environmental management and monitoring, water and energy conservation, material efficiency, waste management, technological and operational excellence, emergency preparedness, housekeeping, horticulture, and others.
- Develop in-house and self-sufficient Environment, Health and Safety consulting and engineering capabilities.
- Focus on environmental engineering and sustainability, pollution control and abatement at source, and waste minimisation.
- Adopt best available technologies (BAT), and best practices in areas such as technology and benchmarking.
- Prepare young engineers for the next level.
- Beautify and maintain the plant to international standards.
- Continually demonstrate that Jindal Stainless is a legally compliant, competitive, forward looking, and environmentally and socially responsible corporate citizen.

## Action

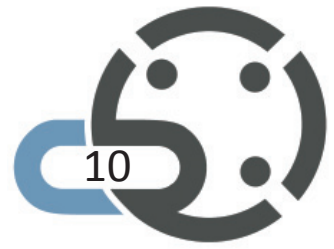
To achieve this goal we:

- Established a truly knowledge-based resource centre – the Centre for Environmental Excellence (CEE). The CEE is supported by a state-of-the-art in-house environmental laboratory, a network of online stack and ambient air-quality analysers, a research and development group, electronic Knowledge Centre (library), and a surveillance monitoring team.
- Implemented an Integrated Management System (IMS) for quality, environmental factors, and occupational health and safety which meets globally recognised standards.
- Gathered the collective knowledge of our staff through active communication and participative sessions. These included fortnightly theme-based campaigns, brainstorming sessions, and reviews. Suggestions on improving our EHS performance are welcomed and rewarded with incentives. There is also zero tolerance of non-compliant behaviours.
- Transformed the concerns of our people into policy and strategy;
- Transferred knowledge through our monthly EHS journal (Saath Saath – We Are All in This Together), and by providing access to real time environmental data and our EHS web portal.
- Efficiently used resources through management practices and technological improvements.
- Continually pushed the implementation of our EMS policy until it became an inherent practice.
- Adopted state-of-the-art pollution control systems.
- Reused 100% of the fly ash generated at the plant to develop abandoned or degraded waste land outside the mill and turn it into public space.
- Developed a comprehensive by-product management plan. The plan calls for all possible wastes to be turned into valuable resources.
- Implementation of housekeeping and a concrete road network inside the entire plant.
- Developed dedicated corporate social responsibility and environmental programmes to develop sustainable conservation and environmental management projects in the local community.
- Achieved accreditations and recognition from both state and national governments.

## Outcome

The initiatives we have implemented have yielded the following benefits:

- Jindal Stainless obtained globally recognised management system certifications.
- We achieved legal compliance and enhanced the sound green governance image of the corporation.
- Gained the goodwill and confidence of our stakeholders.
- The CEE has been recognised as a qualified environmental consultant by the state Environment ministry's Pollution Control Board. The qualification lasts for three years (until December 2014).
- Our workforce has been motivated to become environmentally sensitive and aware! Participative sessions have resulted in sustainable solutions for all environmental issues. Product quality improved and yield has increased by 20%.
- Highly efficient pollution control systems have been implemented, reducing waste and effluent, and improving the working environment and its aesthetics.
- Flue gas waste heat recovery plants and a steam and coke oven gas pipeline network have been implemented across the plant. This has led to a reduction in fuel consumption and greenhouse gas emissions.
- A rain water harvesting facility has been installed to capture, treat and recycle 0.6 million litres of water for plant operations during the rainy season.
- Adoption of sustainable and best available technologies has led to zero effluent being discharged from the plant.
- Recyclable wastes are properly handled with zero spills or leakages. Waste volume has been reduced and material efficiency improved.
- Over 33% of the land area has been planted with trees as part of a Green Belt.
- We received the 2011 Pollution Control Award for the Industrial Sector from the state Pollution Control Board, for exemplary environmental management.
- Many national awards were received during 2011-12 for good green governance, environmental and water management, water conservation, and our anti-pollution drive amongst others.



Jindal Stainless Ltd.

## Energy saved is energy generated

Energy intensity

### Challenge

The steel industry is very energy intensive. Energy accounts for 35 to 40% of the total production cost of stainless steel. Energy is a major raw material and is used heavily in stainless steel manufacturing processes such as melting, casting, hot rolling, annealing, pickling, re-rolling, slitting and others. Energy costs increase each day, leading to higher prices for our products and creating tough competition in the global market. At the same time, wasted energy causes environmental pollution through its CO<sub>2</sub> emissions.

## Action

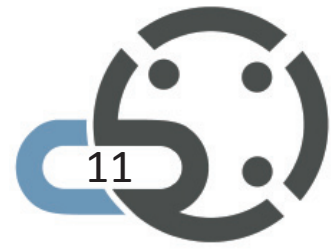
The following actions have been taken to reduce energy use:

- An energy management system collects data on the energy use of each production line.
- Proactive condition-based maintenance is carried out using tools such as thermal imaging, vibration monitoring and improved automation.
- Energy conservation is promoted through energy audits, quizzes, and posters. Energy teams comprising all levels of staff has been established on the shop floor.
- Lines are run at their optimum speed to improve productivity and yield.
- Breakdowns have been reduced through proactive and planned maintenance.
- Furnace efficiency has been improved through automation.

## Outcome

The changes we have implemented have improved energy intensity and:

- Reduced product cost, helping us to compete in the market.
- Reduced CO<sub>2</sub> emissions as energy is saved.
- Reduced the need for back-up power arrangements.
- Increased energy saving awareness within the company.
- Resulted in an award for energy conservation from the national Ministry of Power.



Jindal Stainless Ltd.

# Induction training programme for graduate engineers

Employee training

## Challenge

Our goal when recruiting talented graduate engineers is to transition them to become high performing employees and future leaders of Jindal Stainless Limited. Developing them into self-motivated professionals who understand Jindal's values means they can effectively contribute to the company's performance in a challenging environment.

## Action

A unique programme, based on Jindal Stainless Ltd's knowledge, was developed to grow these trainees in a real work situation. The two year programme is designed to develop all facets of the trainee engineer so that they are a better corporate citizen who can provide leadership to the organisation in the future.

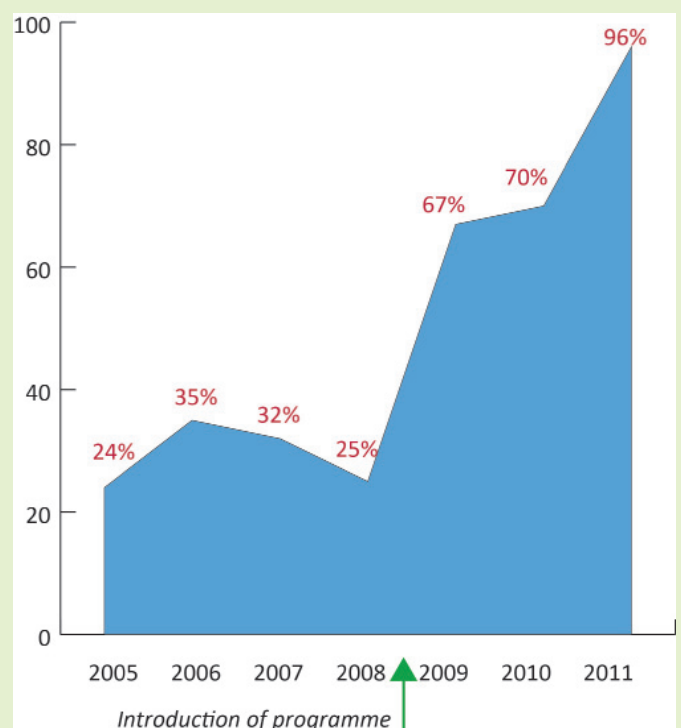
The intense, yet sensitive programme sets new standards in resource development, and provides rich benefits for the young graduates in terms of their personal and professional growth.

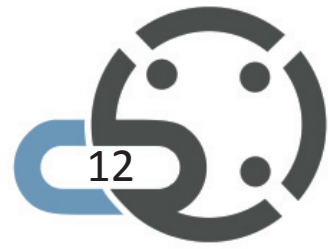
The objectives of the two year training scheme are shown in the following table.

Objective	Achieved through
Familiarisation with the organisation	Training
Awareness of functional processes	Classroom training
Familiarisation with cross functional processes	Cross functional training
Exposure to industry best practices	Industrial visits
Understanding customers	Customer visits
Learning by doing	On-the-job training
Exposure to real assignments	Improvement projects and assignments
Developing reading and comprehension	Book review
Developing managerial competencies	Managerial training
Developing behavioural competencies	Behavioural training
Tapping young minds for innovative ideas and improvements	Suggestions and improvement ideas
Becoming a better corporate citizen	Mentoring
Continuous monitoring of learning and providing feedback	Review

## Outcome

Since the programme was introduced in 2009 our graduate trainees have become highly motivated and retention rates have improved dramatically (see graph).





Jindal Stainless Ltd.

## Instilling a positive safety culture

Safety

### Challenge

As Jindal Stainless Ltd operates a large scale plant with a wide spectrum of activities, it has always been a challenge to create a positive safety culture amongst the local temporary workforce. The workers come from diverse cultural backgrounds and the trades represented vary depending on the project.

To nurture and sustain a safe and healthy work environment we must consistently promote safe behaviour and practices. As well as preventing accidents, this approach also provides motivation and satisfaction for the workers.

## Action

A positive safety culture can only be achieved with the direct involvement of every individual and the leadership line managers. This is continually instilled by enhancing safety vigilance, responsibility, accountability and empowerment at each and every level of the organisation. Specific actions include:

- A safety responsibility matrix was devised for all plants and a designated person placed in charge of safety in each area. These Safety Champions are empowered take action and remain responsible and accountable for safety promotion, issues, and even safety lapses if major near-misses, injuries or accidents occur in their area.
- Three-tier Departmental Safety Committees were established and required to hold structured Safety Meetings each fortnightly in their department. Monthly safety briefings are held with all contractors and there is a monthly review of safety at the Apex Management Committee.
- Monthly Safety Sharing meetings are held with safety professionals from neighbouring industries.

A dedicated Safety Training Centre (STC) was also established. The STC is equipped with multimedia facilities, training modules, a safety library, and safety

videos. It is used daily to provide audio-visual based induction and job-specific safety training.

Enthusiasm and ownership of safety is instilled and sustained through various types of innovative engagement programmes such as counselling, interactive training, and accountability. These are held at regular intervals. Some popular and result-oriented programmes we have found to be successful include:

- Plant-wide displays of safety messages, posters, slogans, and safe work instructions.
- Distribution of pamphlets, such as Traffic Safety Guidelines and Road Map, to all drivers at the entry gate. Safe Material Handling guidelines are given to all lift and crane operators.

As an integral part of our EHS system, various safety studies and training is carried out in order to eliminate hazards and prevent accidents. Some actions include:

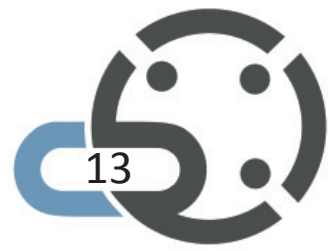
- Safe Operating Procedure and Safe Maintenance Procedures have been developed and are enforced.
- Internal and external audits and inspections are carried out in order to identify breaches of our safety regulations.

## Outcome

The following significant benefits have emerged from our initiatives:

- There has been a sustained focus on eliminating the cause of accidents at source. Proactive control of accident causes (not reactive) and adoption of line responsibility has become deeply rooted at all levels of the organisation.
- Our legally compliant organisation is now achieving global safety benchmarks.
- System-driven best practices are included in our Integrated Management System (IMS) Policy. A goal-driven IMS System, with a high degree of accountability, is in place and policy objectives are being met.
- A safe concrete road network has been established within the plant. Motor cycles are completely prohibited inside the premises.
- Our On-site Emergency Plan has been well tested and is accepted by the statutory authorities. Our well-equipped Emergency Control Room and Fire and Rescue Emergency Preparedness plan have demonstrated that fire tenders can respond to an incident in less than seven minutes at all times of the day.
- A well-equipped occupational health centre (OHC) and crèche have been established.
- Risk assessment of every critical job is carried out, and strict adherence to safe work procedures is observed.
- Better management of hazardous chemicals.
- The longest accident-free period has been achieved. No occupational health diseases have been observed to date.
- Trained process personnel have taken on the role of safety leaders in their respective plant areas.
- Safe, hygienic, and healthy working conditions are provided.
- We meet customer requirements on EHS, and therefore achieve ready acceptance of our products.
- We received the state government safety award in both 2010 and 2011 from the Ministry of Labour and Employment. We have received many other national awards for accident prevention and excellence in occupational health and safety.





Jindal Stainless Ltd.

## Pickling acid management – more than just recovery

EMS

New processes and products

### Challenge

Pickling is one of the processes in the production of stainless steel. A pickling bath, containing hydrogen fluoride (HF) and nitric acid ( $\text{HNO}_3$ ), is used to clean oxide scale off the stainless steel. The scale originates during heat treatment in the steel forming process.

Each pickling bath is used for as long as possible. New acid is added to replace that lost during the metal cleaning process. Eventually, high concentrations of metal oxides mean that the pickling bath needs to be completely replaced. Failure to replace the pickling bath at the correct time can result in poor finish quality of the stainless steel and low productivity.

Replacing the bath results in:

- Consumption of high levels of fresh acid.
- Consumption of high levels of chemicals to treat the waste acids.
- A large quantity of solid material (sludge).

## Action

To overcome these problems, an Acid Management System has been installed. The system enables us to optimise our acid-metal processes including:

- Continuous acid-metal separation
- Maintenance of acid concentrations in the bath through analysis and additions
- Removal of suspended solids removal
- Process circulation
- Acid recovery using the closed-loop pickling system.

## Outcome

Continuous removal of suspended solids from the acid eliminates the need to dump the waste acid due to sludge build-up. It extends the working life of each bath significantly.

Continuous acid-metal separation enables us to remove dissolved metal contaminants and recycle acid back into the pickling process. Using acid filtration and recovery technology, large acid savings are achieved.

Savings in neutralisation chemicals, such as lime or sodium hydroxide, are achieved and the cost of disposing of the resulting precipitated solids is reduced.

Other benefits include:

- Decreased solid wastes from the neutralisation of pickling waste
- Reduced consumption of waste-water treatment plant chemicals
- Reduce consumption of fresh acid and rinsing water.
- Consistent product quality by eliminating process variations
- Increased productivity.



Jindal Stainless Ltd.

## Scientific competency mapping

Employee training

### Challenge

A competency mapping system is essential in order to identify need-based and level-based training, succession planning, job rotation and inter-departmental deployment. The system helps to develop an effective organisational reporting structure and align it with an effective integrated management system (IMS).

The biggest challenge for Jindal Stainless was during the transitional phase of the plant's development – the stage where we moved from project to operation. This was an activity based phase, in which need-based training or identifying competencies was time driven.

## Action

The competency mapping process was initiated through semi-operational, stabilised units with defined positions. Standard operating practices (SOP) were prepared in consultation with the heads of all departments and aligned with the needs of both the technical and behavioural areas. The competency needs were captured in a structured format using a scientific process of assessment. This included:

- Defining competency requirements for each position. The competency assessment was validated by the head of the department.
- Determining scoring scale and weightings. A score and weightings were established based on the responsibility level of each position.
- Assessment of the competency gap.
- Prioritisation of training needs. An annual training calendar was prepared for critical, essential and desired training.
- Assessment of the training needs for each individual for the current and subsequent years.

## Outcome

These initiatives resulted in the following outcomes:

- The list of training activities was prioritised. Critical needs were urgently addressed in the Current Year Training Calendar. Essential and desired trainings were scheduled for subsequent years. A target of three days training was set for each employee, but analysis showed that critical training could be completed in the first year at the rate of 4.08 days/employee.
- The average competency profile was assessed on behavioural as well as functional competencies. The organisational structure of all operational units was frozen based on the defined competencies and this helped in identifying critical positions. They were given priority in terms of in-house and external training and career succession planning.
- Succession planning was performed on the available vacant positions and the vacancies were filled via internal recruitment. Priority was given to the competency rating or profile of the individual.
- An on-line training management portal was developed in-house. Staff use the system to nominate themselves for internal training programmes. The system includes an option which enables department heads to validate the training. It also enables us to track training coverage and assess backlogs.
- Needs-based training modules were developed based on the instruction design (ID) process. Training initiatives were more focused on the needs of the individual and the identified competency gaps. There has been a notable improvement in technical competency and an increased number of training events in the areas of safety, cost control and waste management.
- The effectiveness of the programme was assessed and an internal process check was conducted for all in-house programmes to assess learning effectiveness. Average effectiveness was 8.3 using the Likert Scale (0 to 10).
- Inter-departmental staff movements were initiated based on the results of the competency mapping process.



Jindal Stainless Ltd.

## Training on hydraulics

Employee training

### Challenge

A study of Jindal Stainless Ltd's hydraulic operations showed:

- Frequent system failures
- Very high consumption of hydraulic oil
- High cost of maintenance
- Low employee morale.

## Action

The following actions were taken:

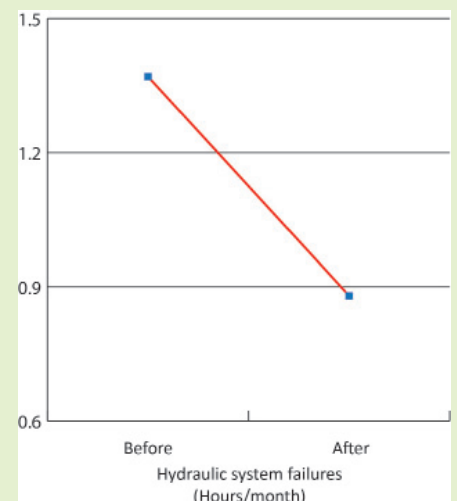
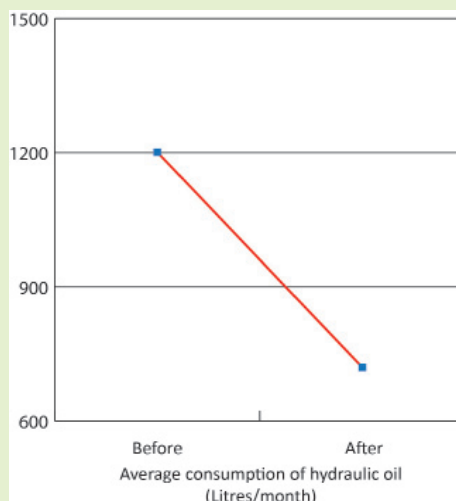
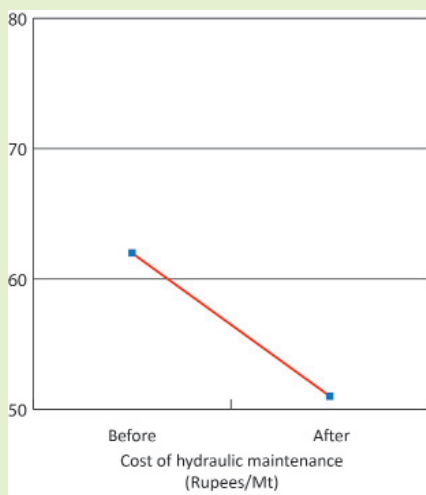
- A thorough study and analysis of hydraulic breakdown patterns, the consumption of hydraulic oil, wastage and maintenance habits was conducted.
- Under the guidance of a hydraulics expert, training and application of the learning was initiated.
- Weekly training was scheduled and a monthly review of improvements was conducted.
- Maintenance practices and the consumption of oil and spares were closely monitored.

## Outcome

The outcome of this approach was:

- System failure was reduced significantly.
- The cost of hydraulic maintenance was reduced drastically.
- Consumption of hydraulic oil and spares reduced considerably.
- A sense of achievement, enthusiasm and a culture of team work prevailed across the department.

This success strategy is being deployed in other departments.





## Nippon Metal Industry

# Development of a low nickel austenitic stainless steel

Material efficiency

Value to customers

### Challenge

The rapid growth in demand for austenitic stainless steels has led to an imbalance in the supply of, and demand for, nickel. This has led to volatility in the price of nickel and problems with its supply. As nickel is a major alloying element of austenitic stainless steels, this causes similar problems in the supply of these stainless steel grades.

## Action

Nippon Metal Industry has been working to develop an austenitic stainless steel which contains less nickel than other austenitic grades. However, nickel provides austenitic grades with their characteristic high corrosion resistance and strength, and non-magnetic properties. These characteristics needed to be preserved in the new grade.

## Outcome

Nippon Metal Industry has successfully commercialised a new low-nickel austenitic stainless steel: NTK D-7S. The grade includes 17.5% chromium, 6% manganese, 2.5% nickel and 2.5% copper. The nickel content is about 70% lower than in grade EN 1.4301/AISI 304.

Tests have shown that NTK D-7S has higher strength than EN 1.4301/AISI 304. It shows similar corrosion resistance and cold working characteristics and can be used in cold worked condition. NTK D-7S also has similar non-magnetic properties and the characteristic high strength of EN 1.4301/AISI 304.

The following table shows the results of pitting tests on the grade compared to other stainless steels. The test was conducted in line with the Japanese standard JIS G 0577.

	<b>NTK D-7S</b>	<b>EN 1.4310/ AISI 301</b>	<b>EN 1.4301/ AISI 304</b>	<b>EN 1.4016/ AISI 430</b>
<b>Pitting potential (V versus SCE)</b>	0.16	0.20	0.20	0.10

Conditions: 80°C, 1000 ppm chlorine





## Nippon Metal Industry

# Improvement in recycling performance

Material efficiency

### Challenge

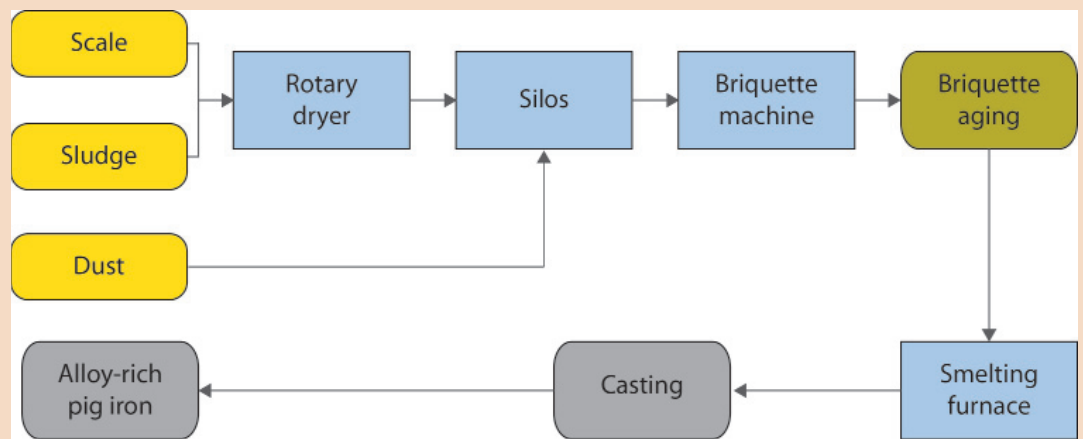
Waste products produced during the making of stainless steel can contain valuable metals such as nickel, chromium and iron. Sludge, which is produced during the pickling process, has typically been disposed of as industrial waste in landfill site.

It is difficult to recover these metals without treating the waste. However, Nippon Metal Industry has been trying to find ways to recycle these waste products.

## Action

Dust, sludge and scale are usually in the form of oxides or hydroxides. They are difficult to handle due to the small size of the particles. The moisture content of sludge and scale also causes handling problems.

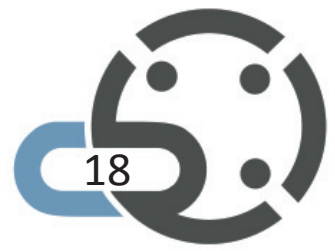
To assist in the recovery of the valuable metals, Nippon Metal Industry has installed a rotary dryer for wet sludge and scale. A briquette machine and electric smelting furnace have been installed to recover the metals from the oxides and hydroxides.



## Outcome

The investment in the new equipment has enabled us to recover valuable metal and decreased Nippon Metal Industry's environmental burden. The following achievements have been noted:

- The amount of pickling sludge going to landfill has declined from 100% to zero.
- Around 9,500 tonnes of pig iron containing nickel and chromium has been recovered in the three years since the project began.



Nippon Yakin Kogyo

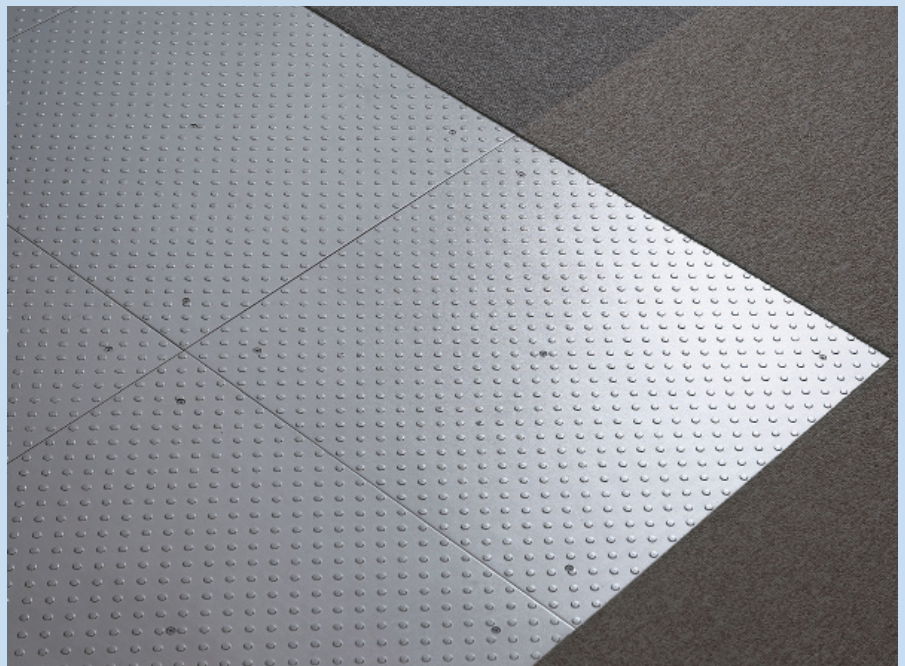
## Round-dot patterned stainless steel plate is easy to clean

Value to customers

### Challenge

Stainless steels are widely used in the food processing industry. Stainless steel plate is frequently used in the floors of food production facilities because of its resistance to corrosion and hygienic properties. Typically, chequerboard patterned plates are used in this application because of their slip resistance.

However, some users have complained about the chequerboard pattern as it collects dust and dirt in the ridges. It can also be difficult to walk on for long periods of time because of the ridges.

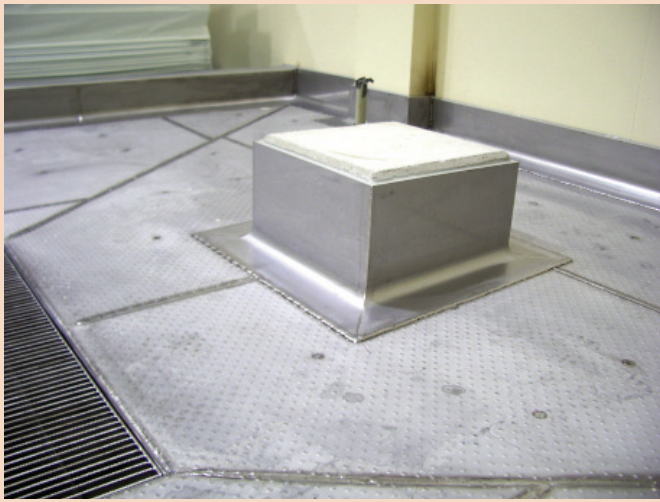


## Action

In order to improve cleanability and reduce shock when walking, round-dot patterned stainless steel floor plate (known as Polka Plate) was developed. The round dots have a diameter of 6.3 mm at the top and 8.0 mm at the bottom and range in height from 0.5 to 1.2 mm.

As the stainless steel is manufactured by hot rolling, durability is much higher than for similar cold rolled patterned plates. The Polka Plate also conserves resources as the plates are thinner and lighter than chequerboard patterned stainless steel plate.

*Examples of Polka Plate in use*



## Outcome

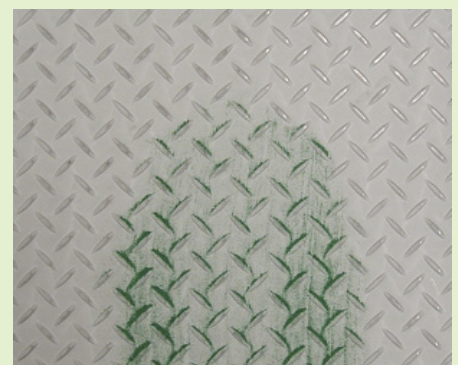
A cleaning test was conducted in order to compare the Polka Plate with chequerboard patterned plate. A broom was used to sweep the stained plates in one direction. Measurements showed that less dirt remained on the Polka Plate after sweeping.

Slip resistance tests were also carried out in accordance with the DIN 51130 standard. In this test, the slipping angle is measured when a person stands on the plate. The results of the test confirmed that the anti-slip

performance of the round-dot patterned plate is higher than that of chequerboard patterned plate.

As well as being easier to clean and more slip-resistant, the Polka Plate is lighter, thinner and longer lasting than traditional solutions.

*Polka Plate (left) and standard plate after cleaning test*





Nisshin Steel Co., Ltd.

## Modified ferritic grade developed for hot water application

Greenhouse gas emissions

### Challenge

During the development of their EcoCute domestic hot water heater, our customer required an economical stainless steel for the tank and pipes. The energy efficient heater is powered by electricity. The stainless steel needed to have good corrosion resistance in hot water (80 to 90°C).

## Action

In conventional water heater systems, grade SUS 444 (18C-2Mo) and modified variations are commonly used. In an effort to define the most suitable grade for the application, extensive discussions were held with the customer. We decided to offer a proprietary ferritic grade which has similar properties to SUS 445J1 (22Cr-1Mo). The proprietary grade is superior to conventional grades in terms of the corrosion resistance of welded parts and has a good track record as a material for waterfront buildings.

## Outcome

The new water heater system reduces energy use by 66% and CO<sub>2</sub> emissions by 50%. In 2009, more than two million units were sold.

Our proprietary grade is ferritic and contains no nickel. Compared with conventional grades, it contains a lower percentage of molybdenum which is expensive and subject to sharp price fluctuations. These properties have helped to promote the use of the new water heating system. The proprietary grade provides a solution which not only saves energy and reduces CO<sub>2</sub> emissions, but also conserves natural resources.



# North American Stainless (NAS)

## Slag dust control

Material efficiency

Safety

### Challenge

Typically, slag is transferred to slag pots from both the electric arc furnaces (EAF) and argon oxygen decarburisation (AOD) process. The slag pots are moved using a pot carrier to an enclosed slag building where the slag is dumped and allowed to cool in the air. It is then placed in a pit where it is quenched with water.

For certain grades of stainless steel, the slag is dumped in the melt shop. The slag is then moved directly to the quench pits in the slag building.

When the slag was dumped and moved, extreme amounts of dust were generated. This affected the air quality in both the melt shop and slag dump building. The dust was bad for human health, required constant cleaning, and damaged equipment over time. When the slag was quenched, vast amounts of dust-laden steam were generated. The steam was extremely dense and impaired visibility. This caused accidents in the slag dump which damaged equipment, and the building structure.

## Action

During 2011, North American Stainless (NAS) addressed the slag management problems by modifying the morphology of the slag, and installing a wet scrubber in the slag building to remove the steam and dust.

The morphology of the slag was modified by reducing the quantity of lime used. In addition, the ratio of lime to dolomite lime was adjusted based on the type of stainless steel being produced.

A large wet scrubber was installed to evacuate the steam from the slag building. The slag building enclosure was also modified to include a 'doghouse' over the quench pit area which collects the steam and dust. To further improve dust-capture efficiency, most of the openings in the building were closed and doors installed.

## Outcome

NAS has been able to modify the morphology of all the slag generated by the EAF and AOD. The change in morphology has greatly reduced the quantity of dust generated when the slag is moved and quenched.

A steam evacuation system consisting of a scrubber and a series of water recirculation ponds was installed. The scrubber quickly captures and treats the dirty steam. In the past, visibility inside the slag barn was impaired for 20 to 25 minutes. With the new scrubber, the steam is collected and removed within 10 minutes. About 20 kg of particulate matter is removed from the slag building per hour. The dust that used to escape the building is now collected by the scrubber and beneficially reused.





Outokumpu Oyj

## Continuous improvement in energy efficiency

Energy intensity

Greenhouse gas emissions

### Challenge

At the beginning of 2010, Outokumpu published its energy efficiency and low carbon programme. The programme sets a long-term target to reduce the Group's emission profile by 20% by 2020 and specifies the main steps we will take to achieve the target. A 5% improvement in energy efficiency is one of the key steps.

The Outokumpu Group's biggest and most modern production facility in Tornio is already known for its unique energy efficiency and highly integrated production set-up. The goal of improving energy efficiency further is a challenging task.

## Action

Outokumpu's Tornio Works made a major energy efficiency investment for district cooling. A total of 50 separate refrigeration compressors in the cold rolling plant will be replaced with a new centralised, district cooling system. To replace the existing electricity driven compressors in the cold rolling plant, new cooling towers and a heat exchanger for free cooling were installed. In addition, two absorption coolers, which utilise process waste heat as primary energy, and two turbo-chillers were installed.

## Outcome

The investment was commissioned in late 2011. As a result, annual electricity consumption at Tornio Works has been reduced by 11 gigawatt hours (GWh). With the new system, the electricity needed for the cooling process is decreased from 15 GWh to 3.9 GWh. The new system also decreases carbon dioxide emissions by 6,700 tonnes.



Outokumpu Oyj

## ECO-EPDs answer green building scheme requirements

EMS

New processes & products Value to customers

### Challenge

Sustainability is an integral part of the decision making process in today's construction industry. Customers' choose suppliers based on cost, schedule, quality and sustainability.

Stainless steel is an ideal material for many architectural, building and construction (ABC) solutions. It's long and maintenance-free life makes it an efficient and feasible material for these applications.

However, the number of green building rating systems has increased dramatically and green building standards continue to evolve. Establishing the environmental credentials of stainless steel is even more difficult when the requirements of different rating and certification systems must be satisfied. It also makes it difficult to ensure the decision makers in ABC projects are aware of stainless steel's excellent properties and environmental performance.

## Action

During 2011, Outokumpu published environmental product declarations (EPDs) for the Group's hot and cold rolled steels. The data is based on a representative mix of the 2010 production data from five of our European plants. The EPDs were issued by the European Construction Organisation (ECO) and are valid for a period of five years. Known as ECO-EPDs, the EPDs are externally verified and satisfy most green building standards in Europe.

In addition to the EPDs, Outokumpu has also issued factsheets on other key sustainable building assessment systems. The factsheets cover the North American/Indian LEED system, the German DGNB, and BREEAM in the United Kingdom. Outokumpu is also CARES certified for sustainable reinforcing steel.

## Outcome

Outokumpu is able to communicate detailed information about the sustainability of our products. The EPDs not only indicate the exceptional sustainability performance of Outokumpu's stainless steels, but also contribute to the establishment of an increasingly sustainable building sector. The fact that we are able to offer ECO-EPDs enables us to provide stainless steel products to a wider range of projects.

The sustainability credentials provided by ECO-EPDs, and our ability to provide information on our stainless steels in relation to green building systems, are already making a difference. They have resulted in Outokumpu being designated the preferred supplier on a number of projects.



Outokumpu Oyj

## Light duplex road tankers reduce emissions and increase payload

Greenhouse gas emissions   New processes & products   Value to customers

### Challenge

Transport is one of the primary energy consuming sectors and generates a large percentage of the world's greenhouse gas emissions. While people and materials need to be transported, climate change and energy efficiency are putting increased pressure on current transportation solutions.

High-strength stainless steel grades enable manufacturers to use thinner gauges in a variety of transportation applications. This can lead to considerable savings in material costs and application weight. Transport solutions created with these grades have more efficient and sustainable life cycles as they save energy and reduce emissions during use.

Our challenge was to find a new stainless steel for sustainable road tankers. The goal was to find a stainless steel with high performance and good overall economy. Together with the customer and their project partners, we decided to investigate if road tankers could be manufactured from Outokumpu's lean duplex stainless steel grade.

## Action

The suitability of Outokumpu's duplex stainless for the new road tanker was studied by Outokumpu and the customer. Extensive material testing was conducted in the customer's laboratory. One of the key tests was bending to determine the ductility of the steel in welded sections. The material's tensile strength was also tested and its microscopic structure examined.

At the same time as the physical testing was carried out, the environmental case for the duplex grade was studied. During 2011, a Life Cycle Analysis (LCA) study of the tanker was published by an independent research institute. The study examined the overall environmental effect of different materials which could be used to make the road tanker. The LCA looked at the total life cycle costs over a period of five years and a million kilometres. The LCA also took account of the fact that, with a lighter structure, the payload of the tanker could be increased. This was significant as the overall weight of road tankers is often the limiting factor in payload weight for road transportation.

## Outcome

The results of the tests were impressive and indicated that the overall weight of the road tanker could be reduced by around two tonnes. This means the payload could be increased by the same amount, yet the tanker would be lighter when empty, saving on fuel costs and emissions on empty legs.

The LCA found that 97% of overall life cycle emissions related to the use phase of the tanker's life. While emissions from the manufacturing phase (including making the steel, welding and fabrication) were somewhat higher for the duplex grade than for other stainless steels, the use of the duplex grade reduced to overall life cycle impact.

Overall savings in energy consumption would be around 8% during the first five years of the tanker's life. This equates to a 100,000 kg saving in avoided CO<sub>2</sub>, and a reduction in fuel costs of around €50,000. The cost of manufacturing the road tanker is also reduced as duplex stainless is cheaper than other stainless steels (with current nickel prices) and the actual amount of duplex material needed is lower.



# POSCO

## Providing a complete customer solution

Value to customers

### Challenge

For home appliance makers, like for other manufacturers, material selection is a critical factor at the beginning of the value creation cycle. Choosing expensive and/or low-yield material at this stage reduces the profit margin on the final products.

Manufacturers always try to find appropriate materials for their products, while suppliers usually try to provide material of acceptable quality at the lowest cost. However, with our expertise as a stainless steel maker, POSCO can provide an entire stainless steel solution which maximises value.

In 2011, POSCO and LG Electronics, one of the world's biggest home appliance manufacturers, united to create a press-formed back-plate for an LG clothes dryer using ferritic stainless steel. Previously this plate had made from austenitic stainless steel which is more costly.

## Action

At the very beginning of our research, we recognised that ferritic stainless steel had the properties required for the dryer application. These include its resistance to corrosion and stress-corrosion cracking (SCC). The main obstacle to using a ferritic stainless steel in the back-plate was whether it could be formed to the shape required.

Analysis of each forming step was carried out using computer-aided engineering (CAE) tools. The tests were carried out at the POSCO Research Laboratory in close cooperation with LG Electronics. Analysis of the CAE results showed that the forming mode for the back-plate was more pronounced by stretching rather than drawing. Ferritic stainless steel is less ductile than austenitic stainless, and obtains more strength from drawing.

The processing design for each pressing step was changed from stretching to drawing mode to exploit the properties of the ferritic grade. The shape design was also optimised for manufacture of the part.

## Outcome

After simulations in the laboratory and trials with the customer, LG Electronics is now utilising ferritic stainless steel to manufacture the complex shaped back-plate. Millions of ferritic back-plates have now been produced and achieved remarkable cost savings for the customer.

This type of activity is a typical example of POSCO's approach to providing a total win-win solution for the customer. In January 2012, POSCO received an appreciation plaque from LG Electronics to acknowledge our technical support.





POSCO

## Reducing acid consumption

Material efficiency

### Challenge

Pickling is a process which removes scale from the surface of the stainless steel surface using both a mechanical process (such as a scale breaker or shot blaster) and a chemical reaction (using  $H_2SO_4$ ,  $HNO_3$ , or HF). The cost of the acid consumed in pickling accounts for one of the largest shares of the overall material costs for annealing and pickling. Regulations also govern the amount of NOx which can be generated in the pickling process, and the amount of nitrogen which can be contained in discharge water.

Reducing acid consumption is an important issue which stainless steel makers should address for both cost-reduction and environmental reasons.

## Action

POSCO has taken following actions to reduce acid unit consumption:

- Recycle low-concentration nitric acid which is released from the Acid Recovery Plant (ARP).
- Reuse a surplus acid in the Cold Annealing-Pickling (AP) Line in the ARP of the Hot AP Line.
- Develop a dosing model in the Cold AP Line to optimise acid input.
- Establish the best conditions for pickling by controlling acid concentration, temperature, and other factors which affect the process.
- Reduce acid consumption by strengthening the cooling capability of an acid which is generated when pickling a ferritic stainless steel with low chromium.

## Outcome

Overall pickling costs have been reduced by US\$2.1 million in 2011 compared to the previous year. Savings on the cold AP line alone include:

- US\$0.5 million by reducing HF use by 29%.
- US\$0.4 million through a 32% reduction in the use of HNO<sub>3</sub>.
- US\$0.8 million by reducing the use of neutralisation units by 77%.

De-nitrification costs have also been reduced by US\$0.2 million.



# Steel Authority of India Limited (SAIL)

## Training for the successful commissioning of a melt shop

Employee training

### Challenge

Salem Steel Plant (SSP) is a special steel unit of the Steel Authority of India Limited (SAIL) which in turn is a Government of India Enterprise. Envisaged as an integrated special steel plant, the cold rolling mill (CRM) was initially commissioned in September 1981. Subsequently, the hot rolling mill (HRM) was commissioned in September 1995. To complete the reverse integration and to enhance capacity for saleable steel products, SSP has recently installed steel melting facilities, expanded the CRM and increased the capacity of the HRM.

In order to meet the schedule for the commissioning and stabilisation of the SMS, a number of challenges had to be overcome. These included:

- Team-building: The highly educated, skilled and dedicated workforce had to be aligned in order to achieve the goal.
- Expertise: As the last major part of the plant was commissioned 15-years ago, there was a shortage of experienced personnel.
- Core competencies: Engineering skills and experience in dealing with liquid steel at extremely high temperatures had to be developed.
- Troubleshooting: In the event of major breakdowns, there were few in-house staff with the expertise needed to repair the equipment.
- Specialised expertise: Employee competency in specialised subjects such as refractory life had to be developed.
- Safety: Regular and intensive safety training was required for all employees and contractors in order to enhance their knowledge of personnel and equipment safety, and to make them aware of the risks involved in the operation and maintenance of the SMS.
- Performance improvement: Workshops on sensitive and critical factors were required to ensure production cost targets could be achieved.

## Action

The following actions were taken in each area:

- **Team-building:** Key jobs and positions were identified early in the project. A team of 42 employees and 15 managers was created and trained.
- **Expertise:** Intensive project management and managerial training was carried out both on- and off-site.
- **Core competencies:** Key employees were seconded to other plants for up to two months to familiarise them with the equipment, technology and processes. A one-month training programme was also conducted at a special steel plant similar to the SMS. Both managers and employees received additional training from equipment manufacturers in India and overseas.
- **Troubleshooting:** To establish the troubleshooting skills needed, training on critical equipment and processes was carried out. This also involved sessions in which experts from other steel plants shared their experiences.
- **Specialised expertise:** Employees were sent to different plants to study critical process in order to enhance their skill levels.
- **Safety:** Training programmes were conducted on safety awareness, accident prevention, working at heights, and working with critical equipment such as cranes and air compressors.
- **Performance improvement:** Various performance improvement workshops have been held with cross-functional teams to address operational problems. Employees working in the areas affected were invited to the workshops.

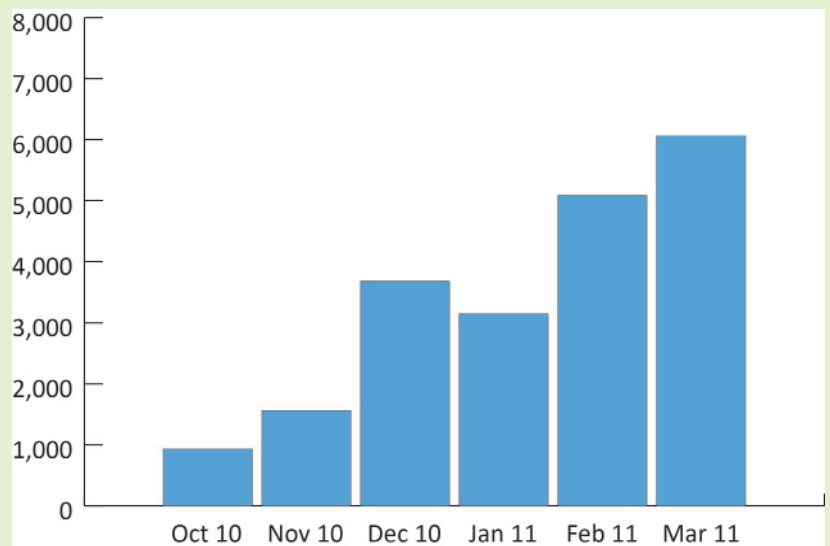
## Outcome

The extensive and comprehensive training plan has enabled the SSP to commence production on schedule. The first heat of carbon steel was produced in August 2010, with the first stainless steel heats taking place the following month. Since then production has increased consistently (see chart). Integrated commissioning was completed in February 2011.

The development of in-house specialist expertise has enabled production levels to be increased significantly. Training on increasing refractory life has more than doubled the life of each lining.

All commissioning problems and technological challenges have been overcome and the SMS has successfully produced low nickel (200 series), 300 and 400 series grades. The cost of production has also been reduced thanks to the training programme provided.

All safety practices are being adhered to and no major accidents have occurred. This has had the double effect of increasing morale and production.





# Taiyuan Iron and Steel (Group) Co. Ltd (TISCO)

## Growing stainless steel production in an urban area

EMS

### Challenge

Taiyuan Iron and Steel (Group) Co. (TISCO) was founded in 1934. After more than 70 years of development and change, TISCO's site has been surrounded by the growing Taiyuan urban area. It is very difficult for TISCO to develop the site further due to environmental protection and real estate constraints. How can TISCO develop in harmony with the city? For a number of years, TISCO has been dedicated to the strategic development and implementation of a plan to develop the enterprise while taking into account our historical responsibilities.

## Action

Our strategic vision is for the harmonious development and co-existence of a green iron and steel enterprise within the urban area. To achieve this, TISCO has applied the ISO 14001 Environment Management standard to our operations. Our actions to date have included:

- Application of advanced process equipment to create a new iron and steel production process. Within a very short period we have cut emissions by phasing out: 1.35 million tonnes of out-of-date coking capacity; 4.96 million tonnes of sintering; 0.70 million tonnes of ironmaking; million tonnes of steelmaking; and 0.90 million tonnes of steel rolling.
- We have established state-of-the-art coking processes and technology including: a 7.63 m coke oven battery; a 450 m<sup>2</sup> sintering machine, 4,350 m<sup>3</sup> blast furnace, 150 tonne ultra high-power EAF; 160 tonne AOD converter; 160 tonne ladle furnace and continuous caster; 2,250 mm hot rolling mill and a wide stainless steel cold rolling mill to streamline the production process. Our technology has been upgraded to ensure high efficiency, energy savings and environmental protection.
- Application of advanced energy saving and environmental protection technology. During China's eleventh Five Year Plan, TISCO invested 8.2 billion yuan to complete 87 key projects in this area. The projects covered solid, liquid and gaseous wastes. Tertiary treated waste water from the city is used as a water source for industrial use, meaning fresh water use for a tonne of steel is cut to just 1.8 tonnes.
- New energy saving technology has been introduced to use all remaining heat and energy from processes. Annual recovery of secondary energy has reduced total energy consumption by 48%. Generation of electric power from other process on the site has reduced total electricity consumption by 25%. Processes are in place to recovery and regenerate liquid wastes such as acids, while advanced treatment facilities have been installed to recuperate and reuse solid wastes.

Using the best domestic and foreign steelworks as examples, TISCO has benchmarked its green management practices and targets.

## Outcome

Implementation of the plan has resulted in the following savings during the eleventh Five Year plan:

- Gradual improvement of environmental protection and performance against our targets. Smoke and dust per tonne of steel has been cut by 62%, sulphur dioxide by 78% and CO<sub>2</sub> emissions by 75%. This has greatly reduced environmental pollution in Taiyuan City and improved life for the local people.
- Gradual improvement in energy performance against targets. Our efforts have saved 1.07 million tonnes of coal, cutting costs by around 0.65 billion yuan and reducing emissions. This exceeded our target of reducing coal use by 850,000 tonnes which was set by Shanxi Province and Taiyuan Municipality.
- Accumulated fresh water use dropped by 38.65 million tonnes, reducing water costs by 0.17 billion yuan. This makes us a model for other iron and steel works and other water consuming industries in arid zones.
- By using advanced technology, solid wastes (known as our secondary mine) are comprehensively utilised to reduce environmental pollution our use of raw materials. The estimated saving is around 0.26 billion yuan.
- Social recognition. TISCO's efforts have been recognised with a number of awards including the National Quality Prize. We have also been named as: one of the 20 Most Socially Responsible Enterprises in China; a National Circular Economy Pilot Enterprise; a Shanxi Province Resource Saving and Environmentally Friendly Enterprise; a Chinese Steel Industry Environmentally Friendly Enterprise; and a model for state-owned enterprise reformation and development by the Central Propaganda Department and State Asset Regulatory Commission of the State Council.



# Taiyuan Iron and Steel (Group) Co. Ltd (TISCO)

## High efficiency utilisation of remaining heat

Energy intensity

### Challenge

As TISCO grows and develops, our requirement for energy also increases. We are determined to meet this demand by turning TISCO into a resource saving and environmentally friendly enterprise.

To reach this goal, TISCO has constructed heat recovery facilities to reuse heat and steam from the sintering, converter and other processes. However, the quality and pressure of the recovered heat differs greatly depending on where it is produced. Long transportation distances also mean the recovered heat cools as it is moved around the plant and it is subject to variations in pressure which are damaging the pipe system.

## Action

It is very clear to TISCO that waste heat must be returned to the production process in order to realise the direct recovery and utilisation of waste heat.

Remaining heat resources which cannot be used directly must be recycled by implementing technical measures which turn low quality heat and steam into electric power. These steps will cut our energy consumption and improve our environmental performance.

The following steps have been taken to achieve this goal:

- Strengthening the management of the steam pipe network.

TISCO has optimised the steam pipe network to reduce the effect of pressure variations and the loss of heat as it is transported. The steam pipe network has been redesigned to separate heat which can be used for production processes from heat which can be used for applications such as heating local residences.

- Direct and highly efficient utilisation of remaining heat and steam.

There are two basic principles for the direct recovery and utilisation of remaining heat and steam in our company. The first is to utilise them locally

to avoid the loss of remaining heat and steam during transport. This meets basic needs. Secondly, energy is utilised as required. Four low pressure pipelines have been installed to meet the different requirement for steam at different works. The pressure can also be boosted if required.

In those areas where a large quantity of steam is required, steam condensate recovery is compulsory. For example, in the stainless steel cold rolling mill, the condensate water is used to adjust the temperature of cleaning lye.

- Reuse of excess heat in summer.

The amount of steam required depends on a number of factors including the season. In summer, a large quantity of steam must be released which leads to environmental pollution and energy loss. To address this, two measures have been taken. Firstly excess heat and steam are used for lithium bromide refrigeration equipment. It has cut the amount of power we need to purchase by 25 million kWh/year. Secondly, remaining heat and steam is utilised for power generation. TISCO generates around 0.4 billion kW/year of electricity.

## Outcome

In recent years, the amount of excess heat and steam which is recovered and utilised by TISCO has gradually increased as we improve our technical installations.

In 2004 we recovered around 0.8% of remaining heat and steam. By 2011 this had risen to 4.7%. The annual percentage of power generated from remaining heat and steam power generation compared to total electric power consumption has risen from 1.9 to 17%. The recovery and utilisation of remaining heat and steam has made a great contribution to energy savings and reducing pollution at TISCO.





# Yieh United Steel Corporation (YUSCO)

## Improvement in compressor efficiency

Energy intensity

### Challenge

Although the European debt crisis affected the stainless steel industry and led to an increase in energy consumption per unit of product last year, YUSCO is still making every effort to improve our energy efficiency.

## Action

Normally the performance of air compressors degrades after long-term operation and power consumption increases gradually.

In 2011, we optimised the operation of three different compressor stations to enhance performance. We also replaced two of the 11 compressors with new compressors. This improved efficiency (kWh/Nm<sup>3</sup>) by 3% compared to 2009.

## Outcome

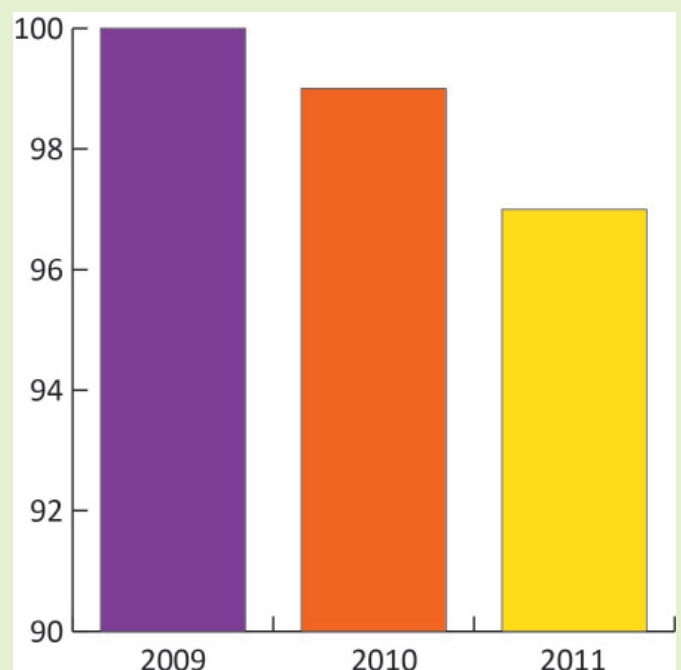
Power consumption has been reduced by 560,000 kWh over the past two years.

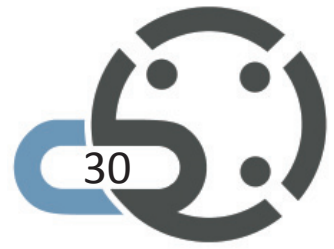
We plan to continue to improve and upgrade the energy efficiency of our production lines in the coming year.

Changes already scheduled include:

- Upgrade of the electrode control software in the EAFs to reduce power demand.
- Gaps in the doors of the annealing furnace will be modified to reduce heat loss.

*Decrease in energy consumption per unit (%)*





# Yieh United Steel Corporation (YUSCO)

## On-the-job training for employees

Employee training

### Challenge

Talent is Yieh United Steel Corporation's (YUSCO) most important capital investment. In order to create a sustainable enterprise, an internal system of on-the-job training has been implemented to ensure a knowledge-sharing culture is established in the organisation.

## Action

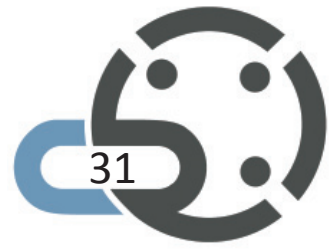
YUSCO implemented our on-the-job training programme in 2011. The programme was implemented in four stages:

- **Planning:** Focussed on creating an inventory of required skills, evaluating the knowledge gap and scheduling training for each department.
- **Implementation:** This stage involved preparing the teaching materials, conducting the training and evaluating the effectiveness of the training.
- **Assessment and review:** Focussed on assessing the appropriateness of lecturers and teaching materials. The work performance of personnel was compared before and after training.
- **Improvement:** Developing solutions to the issues found in the assessment and review stage. Teaching materials and training methods were standardised and a talent-cultivation system was established.

## Outcome

After their on-the-job training, the instrument and electronics personnel were assessed. The results showed:

- Average personnel skills increased from 41 to 90%
- Average maintenance time per task was reduced by 8.8%.



Yieh United Steel Corporation (YUSCO)

## Fuel substitution reduces CO<sub>2</sub> from steam system

Greenhouse gas emissions

### Challenge

Reducing greenhouse gas emissions is part of YUSCO's long-term environmental policy. We do this through our annual energy saving plans which outline the actions we will take to reduce both energy demand and CO<sub>2</sub> emissions.

## Action

Steam is important for both the steelmaking and cold rolling processes. Our steam system uses two kinds of energy: fuel oil and natural gas.

In order to reduce CO<sub>2</sub> emissions, we are substituting natural gas for fuel oil. This has enabled us to reduce the proportion of fuel oil we use from 89% of total heat demand in 2009, to 67% in 2011.

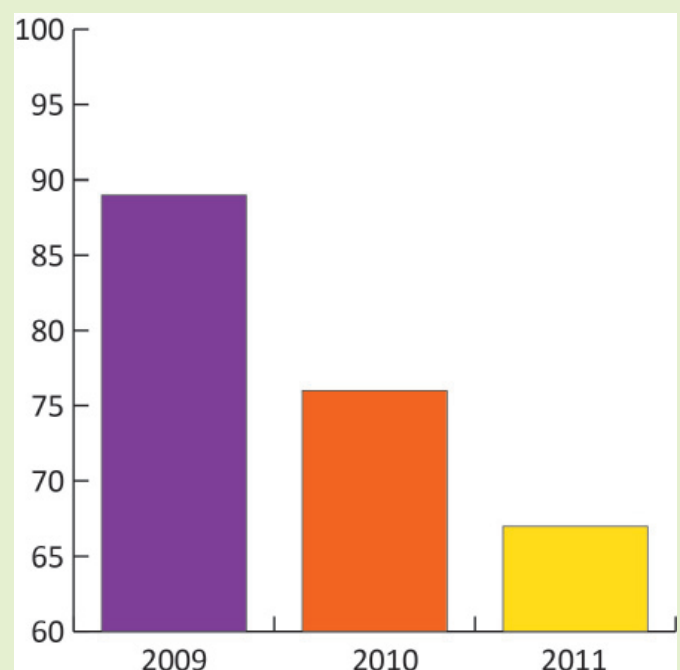
## Outcome

The proportion of natural gas (clean energy) has increased to 22% of total heat demand over the past two years and has reduced our CO<sub>2</sub> emissions by 3.3 million kilograms.

In the coming year we will study our production lines to see where energy efficiency improvements can be made. Actions might include replacing older units or increasing our energy saving equipment to further reduce the amount of energy used. Examples of actions we plan to take include:

- Adopting oxygen-rich or regenerative combustion in the pre-heating ladle of the steelmaking plant.
- Adding an outer burner to our bell-type annealing furnace to reduce natural gas demand.

*Proportion of energy from fuel oil (%)*





## Yieh United Steel Corporation (YUSCO)

# Industry and university cooperation to increase stainless steel use

Value to customers

### Challenge

After visiting downstream stainless steel manufacturers, we found that the Taiwanese kitchen-cabinet industry is facing the following problems:

- Taiwanese kitchen cabinet producers are confronting challenges from low-priced products made in China. Many of them have closed their Taiwanese plants and established new plants in China to take advantage of cost savings.
- In the past, the major stainless steel grade used in kitchen cabinet was EN 1.4301/AISI 304. However, stainless steel prices have been affected by fluctuations in the cost of raw materials in recent years. This has resulted in stainless steel being replaced by metal, wood, melamine and artificial stone in kitchen cabinet production. As a result, the consumption of stainless steel in this market has decreased from 90% to 10%.
- Most Taiwanese kitchen cabinet producers are small or medium-sized enterprises, and many of them do not invest much in research and development. This reduces the industry's ability to develop new technologies or upgrade existing systems.

## Action

YUSCO, the I-Shou University, and Taiwanese kitchen cabinet producers have established a partnership to develop new stainless steel materials and affordable quality kitchen cabinet designs. The goal is to increase the industrial competitiveness of the Taiwanese kitchen cabinet industry. The partners hope that this action will lead to kitchen cabinet producers maintaining their local businesses and an increase in the consumption of stainless steel. The actions taken include:

- YUSCO has developed a new stainless steel grade (AISI 445) to replace EN 1.4301/AISI 304. The new grade contains low levels of nickel. This reduces the effect of fluctuations in the price of nickel on kitchen cabinet makers.
- YUSCO held a New Product Development Seminar to help customers fully understand the characteristics of the new AISI 445 stainless steel grade. The Seminar also covered the processing requirements for the new grade to reduce costs and increase competitiveness.
- I-Shou University established Kitchen Cabinet Design courses to train students. The University invites kitchen cabinet experts to teach students the skills they need. It also arranges for students to

receive practical training in kitchen cabinet plants during their summer and winter vacations. In this way, theory and practice are combined.

## Outcome

YUSCO has successfully developed the new AISI 445 stainless steel grade and offered it to kitchen cabinet producers. YUSCO hopes that the consumption of stainless steel will gradually increase as local production of affordable quality kitchen cabinets improves.

I-Shou University has established a Kitchen Cabinet Design course to cultivate kitchen cabinet design talents. Modern, new and creative kitchen cabinet designs should increase the industrial competitiveness of the local industry.

While it may take some time for consumers to become used to the new 400-series grade, YUSCO will continue to work hard to increase consumption of the new grade and improve the kitchen cabinet industry's performance.





## Yieh United Steel Corporation (YUSCO)

# Modifications to the gravity dust separator in the converter

Material efficiency

### Challenge

A large quantity of metal and metal oxide powder is collected by the gravity dust separator in the converter. YUSCO has stopped using this material as protective bedding for the slag basin and now sends it for recycling. The change was needed to reduce the amount of raw materials we need to store, and reduce the amount of slag generated.

## Action

The gravity dust separator on the converter was modified so that the waste it collects can be loaded onto a tanker and transported to the recycling plant. The recycling centre recuperates the metal in the waste for re-use in the steelmaking mill.

## Outcome

The gravity dust separator on each converter can collect about 900 to 1,000 kg waste. After processing at the recycling plant, about 450 to 500 kg of metal is recovered. This effectively improves our use of raw materials.



# Yieh United Steel Corporation (YUSCO)

## Improvements in slag recycling

New processes & products

### Challenge

Slag contains valuable reusable metals including nickel, chromium and iron. However, when slag is used as the raw material for recycled products, the metals it contains can affect the composition of the product and damage the processing equipment. Recycling the slag to extract the valuable metals can reduce the production cost of steelmaking. Removing them from the slag also enhances the applications for the recycled slag.

## Action

As it passes over the conveyor belt, the slag is classified according to its volume. A jaw crusher smashes large slag into small particles which are then ground into powder by the rod mill. A mesh screen and magnetic separator are used to filter out the metals hidden in the slag.

Grinding the slag in the rod mill facilitates downstream processing and increases the number of applications in which it can be used. If a wet process is used, the slag will not swell when reused, making it a stable raw material for cement and cement products.

## Outcome

Expensive metals are retrieved from waste and used as a raw material for steelmaking. The process also enhances the value and usability of slag, and reduces environmental pollution. Dry slag powder can be reused as raw material for cement or used in cement products such as pavement bricks, horticultural products or wave blocks. This helps to make slag an eco-friendly building material.



## Yieh United Steel Corporation (YUSCO)

# First Taiwanese certification of stainless steel's carbon footprint

EMS

### Challenge

Global warming has become a serious issue and as a result, energy saving and carbon emission reduction have become important issues for enterprises. With the rise of environmental awareness, the concept of low-carbon consumption is becoming deeply rooted in the purchasing behaviour of consumers.

International regulations and policies on energy saving and carbon emission reduction are putting the responsibility for disclosure on businesses. Reducing energy use and emissions has become the social responsibility of enterprises and a trend in business competition.

The steel industry has always been considered to be an industry with high pollution and high energy consumption. But it is the foundation of all industrial development and plays an indispensable role in economic development. Steel is widely used in both industry and households. Calculating carbon emissions from the steel industry can help greatly to reduce both energy use and emissions.

## Action

From the material life cycle perspective, steel is one of the few materials which can be completely recycled. The international trend for greenhouse gas (GHG) management has gradually seen the GHG inventory extended from the organisational-level to the product level.

Therefore, a product's carbon footprint now includes emissions from the upstream production of steel. This is a very important data source for downstream customers who need to calculate the carbon footprint of their products.

YUSCO is the major stainless steel supplier in the domestic market, and has the largest integrated stainless steel mill in Southeast Asia. The integrated steelmaking, hot rolling and cold rolling operations provide raw materials to domestic and international downstream stainless steel product producers.

To highlight the efforts we are making on environmental protection, YUSCO takes the lead in providing an inventory of the carbon footprint of our stainless steel products. We are also actively working on an organisation-wide greenhouse gas inventory. The scope of the inventory covers:

- Acquisition and transportation of raw materials.
- Consumption of energy during the manufacturing process.
- Waste.
- Acquisition and transportation of packaging materials.

## Outcome

Through the joint efforts of all employees, YUSCO has completed the first Taiwanese stainless steel product category rules (PCR) declaration and organisational-level greenhouse gas inventory (ISO 14064-1:2006). We have also passed the verification of DNV (PAS 2050:2008/ISO 14067-1(CD): 2010). This makes YUSCO the first Taiwanese enterprise to define the carbon footprint of its stainless steel products and obtain the first verified PCR declaration in the stainless steel industry. YUSCO applied for PCRs for three product categories: billet; hot rolled stainless steel; and cold-rolled stainless steel. We have also applied for PCRs for six products: billet/slab; black hot rolled coil; No 1 hot rolled coil; 2D cold rolled coil; 2B cold rolled coil; and BA cold rolled coil.

Because YUSCO is an upstream manufacturing industry, the PCR certificate can be used as a reference by downstream manufacturers to calculate the carbon footprint for their products. YUSCO hopes to set an example and motivate upstream, midstream and downstream manufacturers to care for the Earth.



# Yieh United Steel Corporation (YUSCO)

## Improvement in safety protection

Safety

### Challenge

At 23:40 on 20 January 2011, YUSCO's second cold rolling mill was taken out of production so the coils could be recoiled and renovated. In the middle of the recoiling operation, a sudden power failure occurred. The pulling force broke the steel plate on. The left shape roll and broken steel plate fell onto a technician who was looking for coils in the storage section, 20 metres away. The technician's right forearm was cut and he was sent to a hospital for treatment.

## Action

The following actions were taken:

- Boards were immediately put in place to act as temporary protection. If the strip breaks again when the rolling mill is in production, the steel plate is blocked and will not hurt our personnel.
- Health and safety training for the personnel in the unit was reinforced to enhance their awareness.
- The cause of the sudden power failure was analysed and an improvement plan developed as a result.

## Outcome

A safety net has been fully installed around the rolling mill. This ensures that in abnormal situations, or when the strip is broken, no personnel will be harmed.









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