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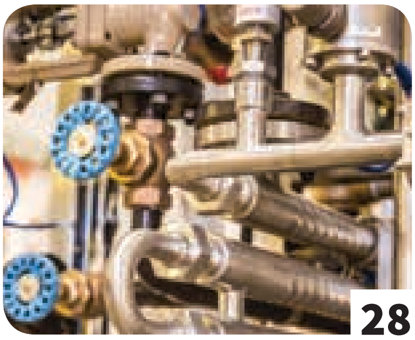

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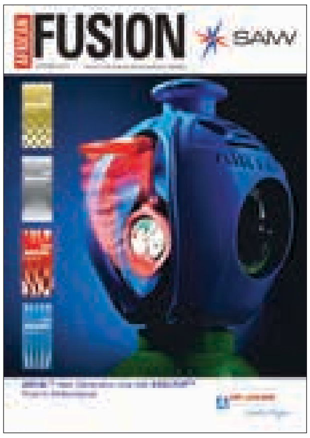

Following the official launch of Air Liquide's Arcal™ New Generation range of welding gases at Electra Mining 2014, a new premium service offering is available with the added benefit of EXELTOP™, which is a cylinder-integrated double stage regulator and flow control solution. *African Fusion* talks to Air Liquide's welding and cutting manager, Rolf Schluep.

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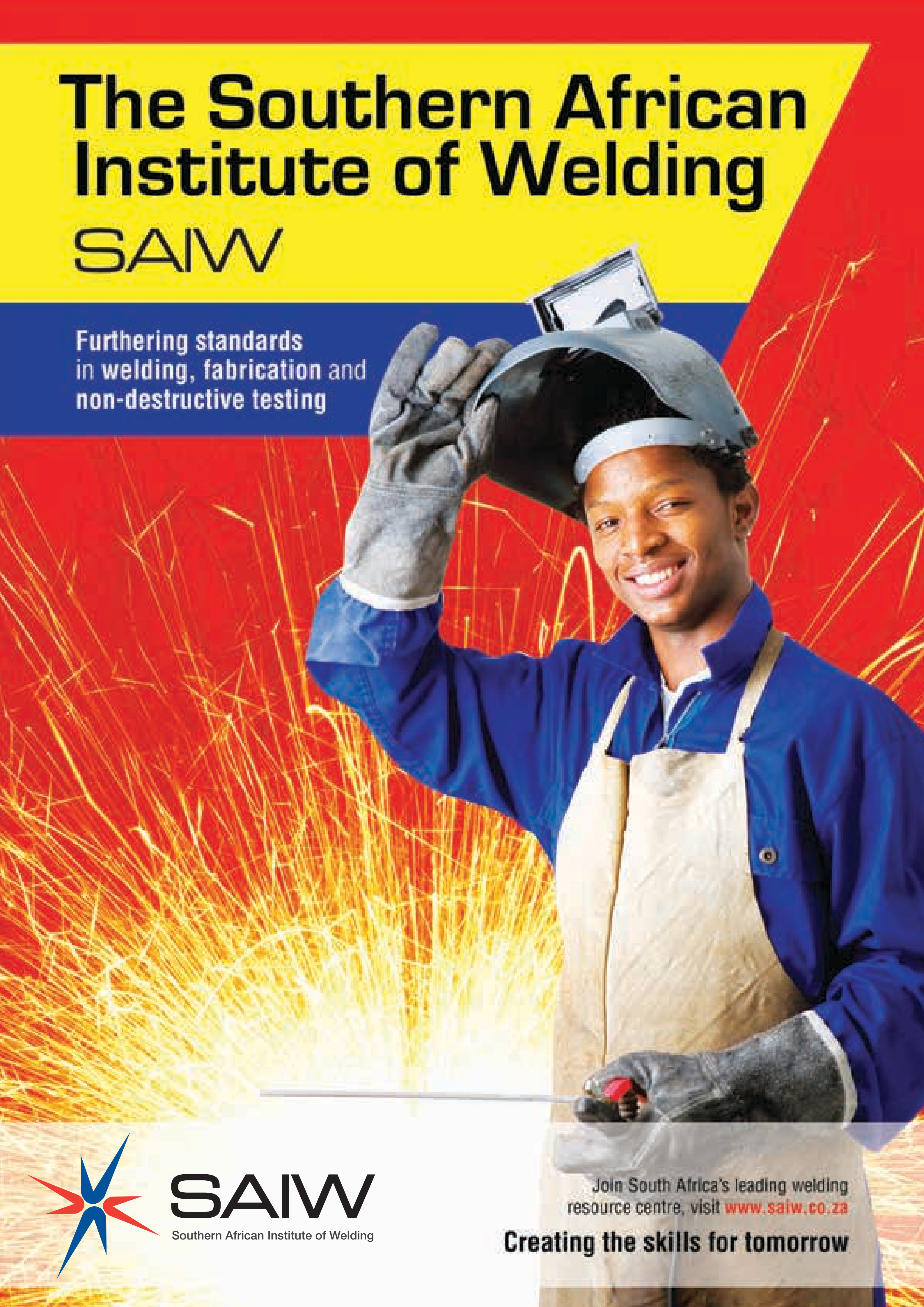

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Creating the skills for tomorrow

2015 has been a year of considerable uncertainty and change. The economy is not returning to growth, the industrial landscape in many places looks bleak, political uncertainty persists and we are surrounded by unrest and unhappiness. We all have to adjust our horizons in order to remain relevant.

With the gap between the 'haves' and the 'have-nots' increasing, South Africa is in a difficult position. We desperately need solutions that can reduce inequality and poverty in South Africa. In this regard, I take my lead from Nelson Mandela, who said: "Education is the most powerful weapon we can use to change the world."

The advantaged people of today are those who have benefitted from good access to education. The disadvantaged have not. As an education- and training–focused Institute, SAIW has a role to play in reducing social inequality and addressing the long-term stability concerns of the country.

A problem that we have in South Africa is that, while a lot has been done to provide training, the people leaving some courses are not sufficiently skilled to add value to industry.

Although private, SAIW training courses depend on industry acceptance, acceptance that demands that we provide skilled people into the fabrication workplace. This is the ideal model. It means that the people we train develop relevant skills towards secure employment. At the same time, industry benefits from the competence SAIW-trained employees bring to the workplace.

Partnership models such as ours, involving training institutes and the industries they serve, are the logical starting point towards upskilling the country. Training on its own is not enough. A good candidate from a training school needs to develop skills through good industrial experience. Both are necessary to develop a well skilled artisan who will add value to industry and the economy.

At SAIW, we have begun to place renewed emphasis on the quality, relevance, value and sustainability of all of our training products, so that we can continue to deliver programmes that can enhance industry's needs and create employment.

Politicians and government agencies also have a role to play, however, it is their responsibility to create the environment that will allow people and industry to succeed.

We are currently on the brink of important project investment decisions. But have we learned from the past or are we going to allow history to repeat itself? In the 70s and 80s we built power stations and refineries, and built up a healthy local skills base. But by the start of the 2010 era, these skills were completely eroded. We are now looking at new project choices to rescue the ailing economy. We can choose between projects that use the skills already developed and those that will leave skilled people on the unwanted shelf. Will we learn from the mistakes of the past and choose projects that allow us to continue to upskill with a view to maximising local potential? If so we can drive the economy and industry into the next upturn, which will come.

And all of us, politicians, government agencies, institutes, industries and private citizens, need to be doing everything in our power to support localisation and local businesses. It would be a tragedy if we again regressed as we did in the 80s and 90s.

May you have a restful break and come back into 2016 invigorated and ready to face the ongoing challenge.

Sean Blake

SAIW executive director, Sean Blake

SA's welding industry

The SAIW's 67th Annual Dinner and Awards ceremony took place on 11 September at Emperor's Palace in Kempton Park. Compèred by cricket legend Fanie de Villiers with entertainment from *'3 Tons of Fun'*, the event brought together key stakeholders and industry leaders from all over the country to celebrate South Africa's 2015 welding successes.

Opening the evening, SAIW President, Morris Maroga, began by welcoming those who travelled from afar, notably: SAIW KZN committee chairperson, Donovan Govender and the KZN SAIW representative Anne Meyer, "as well as our Western Cape Committee Chairperson Corné Coetzee and Western Cape representative Liz Berry."

Welding stakeholders present included Raymond Patel and Ester van der Linde from merSETA ; Jacob Malatse and Matlala Sathekge from the Department of Labour; SAISI's Johan Nell and SAISC's Paulo Trinchero; John Tarboton from SASSDA; Keith Cain from SAINT, along with award winners; SAIW Board members; members of academia; SAIW corporate and personal members; clients and friends of the Institute.

"Tonight would not have been possible without the help of our loyal sponsors," said Maroga, before thanking Afrox; Esab; Hydra-Arc; Xeon Welding; Lincoln Electric; Bureau Veritas; DCD Heavy Engineering; Techtra; Transnet; and WASA.

Following dinner and entertainment, Sean Blake, SAIW executive director, took the podium to announce the award winners.

The best students on SAIW training courses in 2015

"The Institute involves industry representatives in every aspect of the development of a course: the syllabus; the training material; and the examinations," said Blake. "It does this to ensure that its training programmes and the qualifications that are issued are well suited to industry requirements. Using this approach helps ensure that graduates from Institute courses have good prospects of employment and of meeting employer expectations," he explained.

"Anyone attending Institute courses will testify that they are very demanding. A lot of information has to be absorbed in a short amount of time. To be successful takes special effort and we recognise the very best SAIW students through these training awards."

The winners of the training awards receive a voucher worth R20 000, which can be used for any Institute training course, seminar or conference.

Above: *Cornelius van Niekerk, Madeleine du Toit and Corné van Rooyen won the Harvey Shacklock Gold Medal for the best technical paper presented at an Institute event. His father Oostewald van Niekerk (right), received the award on Cornelius' behalf, along with Van Rooyen (centre).*
Left: *Michael Godfrey, who achieved distinctions in Welding Inspectors Level 1 and Level 2, receives the Phil Santilhano Memorial Award from SAIW president, Morris Maroga.*

winners

The SAIW Presidents' Award For NDT

SAIW has been training NDT personnel for more than 30 years – the same length of time that the Institute has offered training in welding. "NDT is a very important part of the Institute's programmes and we want to encourage more young people to enter this field, which offers good career opportunities. The Presidents' award recognises the top NDT student on Institute courses. The award is made in the name of the past presidents of the SAIW who have helped guide the Institute to become a prominent part of the local welding industry and to be South Africa's reference point for high quality training in welding and NDT," Blake said.

"This year, it was very difficult to differentiate between the marks of two candidates, so the SAIW Certification Board decided that both will receive awards. The awards go to Petrus Stephanus Rossouw for outstanding marks in one volumetric method and two surface methods at Level 1 and to Lorraine Lerato Montsho, who achieved outstanding marks in one volumetric method and one surface method at Level 2," announced Blake, adding, "this is the second time that Lorraine has won the NDT training award."

The Phil Santilhano Memorial Award

The SAIW's second training award is the Phil Santilhano Award, which is presented to the best student on the Institute's courses in Welding Supervision and Inspection. The award is made in the name of Phil Santilhano, who was one of South Africa's leading welding technologists and is remembered for his research and development on submerged arc and electro-slag welding of heavy wall pressure vessels. He became the Institute's first full time employee when he was appointed technical director in 1977.

"Our winner tonight is Michael Godfrey who achieved distinctions in Welding Inspectors Level 1 and Level 2," revealed Blake.

Harvey Shacklock Gold Medal Award

The Harvey Shacklock Gold Medal is awarded to the author of the best technical paper presented at an Institute event. Harvey Shacklock was the managing director of BOC (British Oxygen Company) now Afrox. He was instrumental in founding the South African Institute of Welding and, in 1948, became its first president. Afrox, part of the worldwide Linde group, generously donates a gold medal for the award.

The Institute's Gold Medal Award for 2015, the Institute's highest accolade, was awarded to Hydra-Arc, represented by, from left: Nicholas Correia, Riaan Kruger, Geo Dunn, Riaan Carstens, Jan Maswanganyi (CEO), Alan Smith, Eleanor Venter, Ewan Huisamen, Ryno van Niekerk, Armand Keulder and Johan Victor.

"This year we are very pleased to be recognising Cornelius van Niekerk for his presentation *'In situ alloying of AISA 410L martensitic stainless steel with nitrogen during laser cladding'*. The paper was co-authored by Corné van Rooyen and Madeleine du Toit. Cornelius van Niekerk is currently in Australia, as is Madeleine du Toit, but in Cornelius' absence, his father, Oostewald van Niekerk, will receive this award," anounced Blake.

The SAIW Gold Medal Award for 2015

The final award for this evening is the Institute's Gold Medal Award. The award was introduced in 1966. It is the Institute's highest award and can be made to a company or an individual in recognition of outstanding contributions to welding technology or to the Institute.

"For 2015 the award is being made to Hydra-Arc. The award citation reads: *"In recognition of the company's commitment to skills development in South Africa as exemplified by its involvement in welder artisan training; innovation in the field of fabrication in its workshops; for completing the largest storage tanks fabricated in South Africa for Sasol; commitment to quality in welding as demonstrated by numerous quality management certifications in place and international awards made in recognition thereof'*.

Hydra-Arc has developed the Sky-Hill fabrication facility, which is a fully integrated facility with 75 000 m^2 under roof. The company fabricated five propylene (bullet) storage vessels in 2013, measuring 59 m in length and weighing 446 tons each, which were the largest vessels ever manufactured in South Africa at that time. The vessels were heat treated as a single unit in a one-of-a-kind heat treatment furnace built by Hydra-Arc, completed ahead of schedule and delivered to the Sasol Secunda complex.

The group began a skills development programme in 2002, which has expanded over the years to the establishment of the Mshiniwami Training Academy with capacity to train up to 1 000 artisans per year.

The Hydra-Arc Group is a proudly South African business that has proven that, by developing local skills and paying attention to quality and on-time delivery, it is possible to be successful and competitive in this challenging industry.

The award was presented to Hydra-Arc's chief executive officer, Jan Maswanganyi, by SAIW president, Morris Maroga.


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EN 15085: SA's first two successful certifications

Following the certification of Transnet Engineering's Koedoespoort and Durban facilities to ISO 3834 Part 2 earlier this year, SAIW has now facilitated the first EN 15085 CL1 certification in South Africa, at TE's Durban bogie fabrication facility. In addition, VR Laser Systems has become the first EN 15085 CL2-certified railway component manufacturer in the country.

Herman Potgieter of SAIW Certification (centre) photographed with Duisburg-based GSI SLV auditors, Martin Czysch (left) and Albrecht Hans (right), following the first successful EN 15085 audits in South Africa.

SAIW Certification's German partners, GSI SLV, represented by Martin Czysch and Albrecht Hans, visited South Africa and the SAIW during the last week of October to perform the first ever EN 15085 audits of local welded railway vehicles and component manufacturers.

While ISO 3834, which defines the quality requirements for fusion welding of metallic materials, is a requirement for railway vehicle and component manufacturers: "it is only the base requirement," says Herman Potgieter of SAIW Certification.

"EN 15085 is a product-specific standard for the construction, manufacturing and testing of welded railway vehicles. As such there are specific requirements in the EN 15085 standard to ensure the quality and safety of railway equipment. Original equipment manufacturers (OEMs) such as Bombardier, CSR, CNR, GE, and Alstom, therefore, require that their subcontractors are EN 15085-certified in order to guarantee the quality and safety of the products they are manufacturing," he says adding, "if our fabricators, want to make the most of the once-in-a-lifetime opportunity to participate in current rail rejuvenation projects, they must comply with both ISO 3834 and EN 15085 requirements."

Transnet Engineering's ISO 3834-certified Durban facility was successfully audited by GSI SLV's representatives for certification to EN 15085 CL1: the highest certification level. Potgieter explains: "CL1 certification applies to safety relevant components such as bogie frames and bolsters, body-shell components and under-frame structures," he says. "Certification to this level attests to the progress that TE has made, with the help of Bombardier, towards becoming a world-class manufacturer for the railway industry," he adds.

Following on the heels of this success, the German auditing team moved to Dunswart in Gauteng to audit component manufacturer VR Laser, a local fabricator of steel products for a variety of end-users in the defence, mining, rail and transport sectors. From a railway perspective, VR Laser makes frames for Knorr-Bremse, a global OEM for hydraulic, pneumatic and electrical braking and chassis management systems used by several locomotive OEMs.

VR Laser Systems' audit was also successful and the company will be issued with its EN 15085 CL2 component certificate within a few weeks.

According to VR Laser's CEO, Pieter van der Merwe, the issuing of EN 15085 CL2 certification attests to "our company's global competitiveness and adherence to international quality requirements".

"The certification allows VR Laser to fabricate components for the railway industry to European standards – a standard that is being utilised not only by European railway designers, but by the Chinese. Our certification will allow VR Laser to actively pursue fabrication work for the railway industry, in particular for the Transnet 1064 loco project," says Van der Merwe.

Says Hans of GSI SLV: "We both believe that the companies we have seen in this country have excellent potential. All they need to do is to focus more strongly on the specific EN 15085 requirements, with respect to personnel, supervision, training and welding procedure development.

"We see typical ASME/AWS-style compliance in this country, but 15085 is more European and more detailed. The supervision personnel requirements, for example, specify IWT, IWE and IWS qualifications, which, although International, are more commonly applied in Europe,"

VR Laser manufactures steel products for a variety of end-users in the defence, mining, rail and transport sectors. The company has just been successfully audited for EN 15085 CL2 certification, which enables it to construct, manufacture and test welded railway components to international standards.

he says, adding that these issues are not difficult to overcome.

"The facilities are good, there is a good labour pool and South African labour costs are not yet at US or European levels. So, as long as the training and approval processes can be brought in line, there is a lot of potential here for companies to manufacture for the global railway market," he assures *African Fusion*.

Adds Czysch: "We also urge manufactures and welders to pay more attention to housekeeping. If the earth clamp is not secure enough or the gas shroud is covered in spatter, then perfect welds will be impossible to achieve. These things are important."

"A truck driver, for example, has a responsibility for the safety of the truck," continues Hans. "He needs to make sure that the brakes are working properly and the tyres are pumped up. Similarly, a welder must take care of his equipment to give the best possible chance of producing good quality welds," he concludes.

Systems, quality and NDT training: changing roles at SAIW

As a result of renewed emphasis on the quality of SAIW's offering and, in particular, on training quality, SAIW has appointed Harold Jansen to the post of systems and quality manager. Filling Jansen's role as NDT training manager and manager of the SAIW NDT training centre is Level 3 NDT inspector, Mark Digby.

Systems and quality: Harold Jansen

Harold Jansen, SAIW's former NDT manager, has been appointed systems and quality manager to oversee the internal quality of systems and service delivery across the three non-profit companies (NPCs) – SAIW, SAIW Certification and SAIW Foundation – that now constitute the SAIW Group.

"Each entity contributes a unique function towards the products delivered by the SAIW Group," says Jansen. "The Group has, therefore, established the systems and quality position to establish systems and to constantly monitor and improve the quality of the services and products delivered," he explains.

While the position does not change the role of functional managers in any way, all departments will now be expected to comply with and maintain the agreed systems and quality standards that are established.

Inconsistencies will be identified through established pro-active and reactive feedback loops. These will trigger resolution processes via appropriate panels or committees.

Jansen's medium term priorities include:

- The rollout of an SAIW Online registration and administration system during the first quarter of 2016.
- The harmonisation of SAIW's various quality management systems into one ISO 9001-accredited system.
- Aligning all SAIW products with international and national requirements.
- The proper harmonisation of training and qualifications in NDT and welding-related courses.
- To create and maintain a document control procedure and to systematically modify SAIW notebooks and training manuals to comply.

The new position addresses impartiality by ensuring that established processes and independent staff are used to monitor and drive the quality and consistency of the services delivered by SAIW.

NDT training and centre manager: Mark Digby

As part of SAIW restructuring during 2015, Mark Digby, an NDT stalwart of South Africa's Power Industry, has been appointed to the post of NDT training and training centre manager.

Digby rejoined SAIW in February this year as a senior NDT lecturer, having previously been employed twice before: from 1995 to 2002 and from 2007 to 2011. "I started my career as an inspector at Hall Longmore from 1980 to 1989. Then I decided to do and apprenticeship and I became an electrician," he says.

In 1990, Digby joined Howden Power as the quality control vendor inspector for the ID and FD fans for Eskom Power stations.

He joined SAIW for the first time in 1995, working with a NDT team that included Ben Beetge. "We were the trainers, the training organisers and the planners and we put together all of the initial NDT courses for the SAIW," he relates.

In 2003, he was invited to join Rotek Engineering – the Eskom Group subsidiary for servicing plant – as its Level 3 NDT inspector. "I was responsible for NDT on centre-line components on turbines and generators, with responsibility for all NDT carried out on Eskom plant being serviced by Rotek," he adds.

After nearly five years, he returned to SAIW to teach. But in 2011, Digby was offered the opportunity to become the Eskom Group's Level 3 inspector, possibly the most demanding NDT position in South Africa. "The Eskom job became too big for a single person, though, and I took the opportunity to return to SAIW earlier this year as an NDT trainer and senior lecturer.

"When the new structure was created following the management change, I applied for the position to head up NDT training and to manage the NDT training centre," Digby tells *African Fusion*.

"I will be focusing on training and training courses; updating material, making sure the training is conducted properly, auditing the lecturers; and running the NDT training department," he says.

With the addition of the Durban branch, a consolidation and harmonising of the courses is needed, – "primarily for L1, L2 and L3 NDT personnel on the different NDT techniques". "We also have a role supporting the Weld Inspectors' courses with NDT input and we offer an NDT appreciation course for engineers," he adds.

A medium-term goal for SAIW's NDT training centre is to introduce advanced techniques that are not currently on offer at the Institute: eddy-current testing (ET); phased-array UT; time of flight diffraction (Tofd); and Digital Radiography.

"We will be sending our lecturers for formal testing, either overseas or with local specialists, with a view to establishing these courses locally," Digby says.

SAIW KwaZulu-Natal branch opens

SAIW KwaZulu-Natal has opened its offices at 40 Essex Terrace, Westville Durban. "We are extremely pleased to have found the right premises for our new, fully-fledged KwaZulu-Natal branch," says SAIW executive director Sean Blake. "There is so much potential in this region and having a branch here will help an ever-increasing number of people to benefit from welding and NDT training."

Blake says the interest and enthusiasm shown by the newly formed KwaZulu-Natal committee is most encouraging. "The first chairman, SAPREF's Donovan Govender, is keen for the committee to make a difference in the local industry and I have no doubt that they will do just that," he says.

The new SAIW KwaZulu-Natal branch will be housed in offices at 40 Essex Terrace, Westville Durban.

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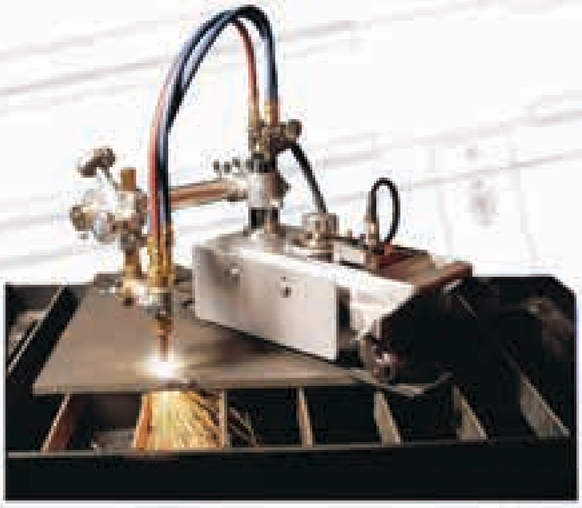

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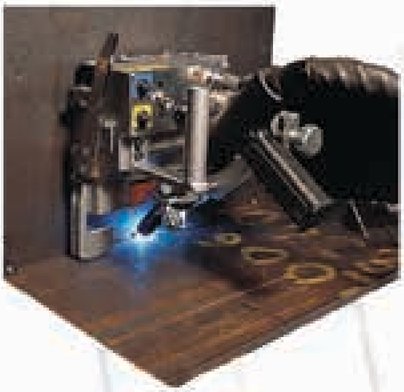

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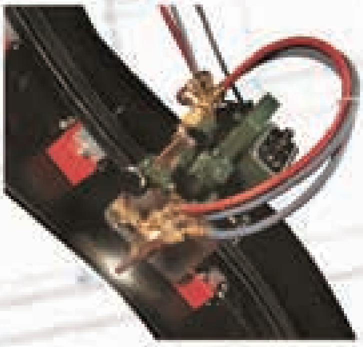

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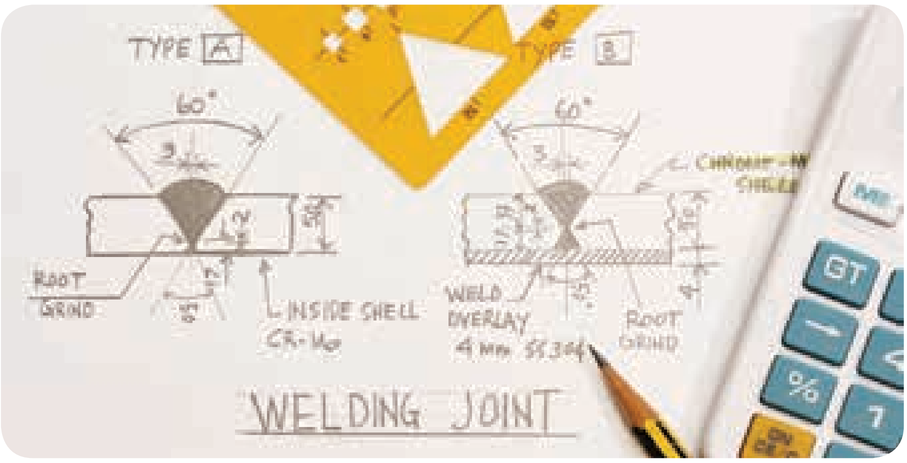
SAIW's entry-level courses for fabrication personnel

In support of the upskilling of welders, shop floor personnel and fabrication supervisors, SAIW has introduced modular short courses, most notably a welding symbols course and an introductory welding quality control course.

The Basics of Welding Quality Control is a course that enables people who have no industry experience to familiarise themselves with the importance and the basic principles of welding quality. The course content – which includes an introduction to common welding processes; material science; inspection techniques; welding and fabrication codes; quality control documentation and basic mathematics and science – is derived from the foundation week of the SAIW Welding Inspector Level 1 course. It is, therefore, ideal for those who do not meet entry requirements for longer courses.



"This two-week course, which meets the syllabus requirements for Module 0 of the IIW suite of courses, can be used for access to IIW Welding Inspection, Welding Coordination and Welding Supervision courses – and these are becoming increasingly important for companies that wish to comply with ISO 3834 or to be certified to EN 15085 for railway vehicles," says Shelton Zichawo, SAIW training manager.

About Welding Symbols is a one-day course that reviews the use of welding symbols in the fabrication environment. Welding symbols convey to welders/fabricators the position and size of welds, the amount of weld metal to be deposited and the types of joint. Welders who work with fabrication drawings must be able to understand and interpret these symbols so that the joints they produce meet requirements.

The course covers the European system for welding symbols (ISO 2553) as well as the US system (AWS A2.4).

In addition to upskilling in-house-trained welders, the course is ideal for welding supervisors, quality controllers and welding inspectors. It is also valuable for engineering design, detailing and draughting personnel entering the fabrication field.

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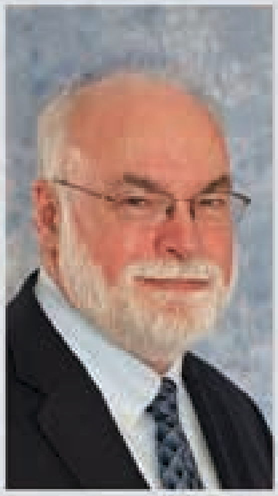


Arcal New Generation with EXELTOP: a premium shielding solution

Following the official launch of Air Liquide's Arcal™ New Generation range of welding gases at Electra Mining 2014, a new premium service offering is available with the added benefit of EXELTOP™, which is a cylinder-integrated double stage regulator and flow control solution. *African Fusion* talks to Air Liquide's welding and cutting manager, Rolf Schluep (left).

Since the launch of Air Liquide's New Generation welding gases at Electra Mining in 2014: "We have seen consistent double digit growth in the first year of sales," begins Schluep, adding, "customers who have been exposed to the new range of shielding gases have see the immediate advantages of the simplicity, reliability and high-performance that the four gases in the range can offer." The gases are based on simple but very accurate two-part mixing philosophies. Arcal Chrome, Speed and Force consist of mixtures containing high purity argon and increasing percentages of CO_2 – for welding stainless steels, thinner and thicker section carbon steels, respectively – while Arcal Prime is high purity argon for the welding of active and reactive materials such as aluminium or titanium.

Designed to suit 80% of all welding applications, the Arcal New Generation range has become the backbone of Air Liquide's welding offering. "We are systematically displacing other gas mixtures and during demonstrations, we have experienced particular success with Arcal Speed, which enables spray transfer mode with low spatter welding at reduced heat inputs," Schluep notes.

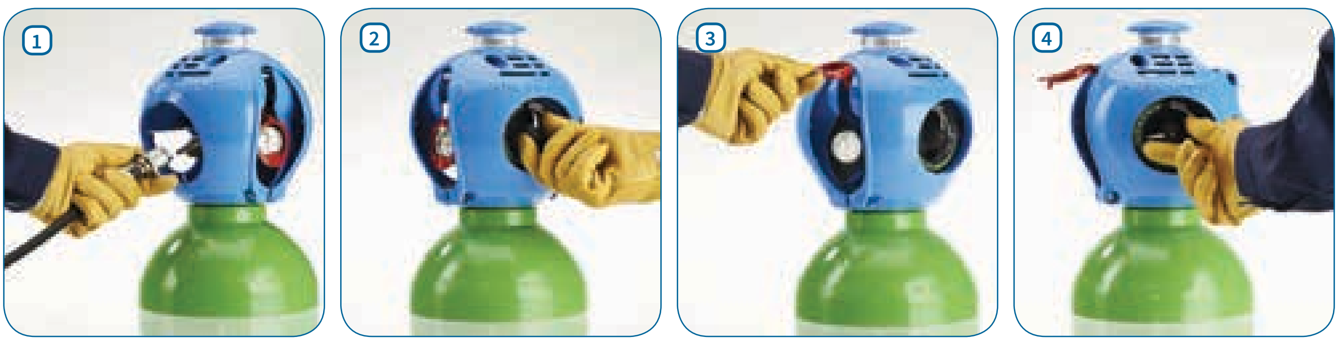
Also showcased as a new development at Electra Mining 2014 was Air Liquide's EXELTOP™ cylinder solution. "EXELTOP is now available for general release as part of our premium service offering" Schluep tells *African Fusion*.

Built into a protective aluminium shroud on top of Arcal New Generation gas cylinders, the EXELTOP system has a double stage regulator. Schluep explains: "By opting to use our premium shielding service, customers no longer need to buy or maintain regulators or flow meters. Every gas cylinder is delivered with a double-stage flow regulation built in. Welders simply need to connect the gas hose from the welding machine to the cylinder, via a quick coupling adaptor to the EXELTOP unit on the cylinder. A lever system is used to open the cylinder and a clearly indexed graduated hand wheel allows the outlet pressure or flow to be accurately set."

Schluep further explains that welders no longer need to search for spanners to tighten or unscrew regulators or cylinder keys to open gas bottles. "It's a plug and play system with simple connectivity that delivers immediate accuracy. The key advantage is the overall cost saving.

"In our experience, regulators on the shop floors are often in an appalling condition as they are either damaged or poorly maintained. Of particular concern, is that they are used despite not working correctly and are usually only replaced when they are completely broken," he says, adding, "these common problems will not occur with EXELTOP cylinders as they are inspected and maintained by Air Liquide during the refill process and routine cylinder inspection cycles."

Regulators also have a tendency to go missing. "We know of customers who have to remove the regulators from their cylinders on a daily basis for safekeeping so as to avoid theft," Schluep notes. Despite the obvious frustrations of the removal process, many welders do not have the correct equipment to install and remove the regulators and are likely to damage the bullnose. He proceeds to explain that one also needs to take into account the time spent looking for tools and having to install and remove the regulators at the beginning and end of every day. "With EXELTOP, the regulator is installed in the cylinder and cannot be readily detached. The only interface



EXELTOP™ is quick to use. 1: Couple the gas hose to the EXELTOP using the quick connector. 2: Set the regulator/flowmeter to zero. 3: Pull up the on/off lever to open the cylinder. 4: Adjust the pressure/flow on the graduated hand wheel. When welding is complete, the on/off lever is pushed down and the gas flow is closed.

between the welding machine and the cylinder is the quick connect coupling for the hose, which we supply. This system facilities quick cylinder changes and allows the welders to focus on welding rather than having to manage tools, regulators and potential leaks," Schluep says.

"With a traditional RPV (residual pressure valve) cylinder, a welder would often connect up the regulator only to find that the cylinder is nearly or completely empty," he continues. Air Liquide's has resolved this problem by adding a gas contents indicator to its EXELTOP solution that can be read at any time, even when the cylinder valve is closed. This allows anyone to check which cylinders are full and which are empty. "This premium solution is a product differentiator for Air Liquide. Where quality, consistency, productivity and safety are all prioritised on a fabrication site, Arcal New Generation gases with EXELTOP offer a solution that is unique to Air Liquide," Schluep argues.

Arcal Micro-Bulk

Another exciting development within the New Generation product range is Air Liquide's premium liquid bulk gas delivery option aimed at medium- to high-volume consumers of New Generation gases. Called Arcal Micro-Bulk, this is a liquid argon-based solution that uses the company's newly developed dynamic onsite mixer to produce a highly consistent shielding gas mixture.

Air Liquide's Dynamic mixer relies on robust preset mixing blocks, which are tamperproof and comply with ISO 14175. The mixer has no moving parts and does not require electricity. "Regardless of the draw off rate, these mixers will continue to offer ISO 14175 compliance, which is unusual for bulk onsite mixers, so this solution is ideally suited to industries requiring high quality and consistency – the automotive industry being one example.

"This onsite mixing solution offers the consistency of cylinders from a bulk supply, which is everything industries need, namely cost effectiveness, high performance and consistently accurate mixes," Schluep says.

Also novel, this patent-pending onsite gas delivery system arrives tested as well as calibrated, in a protective stainless steel container cage with a liquid argon tank, a dynamic mixer and a manifold of CO_2 cylinders. "Once off loaded and laid down, the system can be connected to the gas reticulation network and is ready for use within hours," he reveals. Traditional onsite mixing systems needed pre-constructed plinths, secured areas and power supplies. In contrast, Air Liquide's Micro-Bulk solution is 100% modular and simple to connect to an existing pipeline.

From a security of supply perspective, Air Liquide's Micro-Bulk solution employs a GSM-based mobile communication network that monitors tank levels so that Air Liquide's distribution centre can effectively manage refills when gas supplies become depleted. "With this additional layer of protection, we are one step closer to ensuring 100% uptime of customers' production facilities." Schluep notes. As soon as liquid levels drop below a pre-defined level, a refilling order is created and a tanker is dispatched to the site.

In support of Micro-Bulk deliveries of New Generation gases, Air Liquide South Africa has added a state-of-the-art argon tanker to its South African fleet. "Through Scania South Africa, we have procured a new tanker dedicated to Micro-Bulk customers. In the past, Air Liquide would procure the chassis and the storage vessel separately and have an independent specialist marry the two units locally, which would often negate the warranties," Schluep explains. "But for this vehicle, Scania South Africa has overseen the build process and steered the project logistics, which included homologation and licensing. Before sending the chassis to Cryolor in France, Scania optimised the chassis to facilitate an additional 10% payload on the vehicle. Once the chassis arrived in France, the vessel was fitted by the OEM, which assured all warranties.

"The vehicle is built to the highest possible European standards. It has ABS, a lane departure warning system, adaptive cruise controls, automatic chassis levelling to compensate for liquid movement in the storage vessel, pre-tensioned seatbelts and steering wheel airbags. From an efficiency point of view, we have achieved fuel efficiency savings of 19% in the first six months of use, compared the company's previous generation bulk tankers," Schluep reveals.

Arcal New Generation Micro-Bulk users include general fabricators, steel construction companies along with automotive OEMs and component

Air Liquide's patent-pending Arcal Micro-bulk onsite gas delivery system arrives tested and calibrated in a protective stainless steel container cage with a liquid argon tank, a dynamic mixer and a manifold of CO_2 cylinders.

In support of Micro-Bulk deliveries of Arcal New Generation gases, Air Liquide has added a state-of-the-art Scania argon tanker to its South African fleet.

suppliers. "We see several expansion possibilities, particularly in the high-tech fabrication industry where robotic welding dominates," he suggests.

"With our Arcal New Generation welding gas range, EXELTOP and Micro-Bulk solutions, we believe that we have set the base for growth in our targeted markets and we will continue to focus on these industries. Looking towards the future, we have already started developing innovative solutions for the laser cutting and welding industries. Similarly to the approach we have taken in the automotive and fabrication industries, we believe that we can add significant value to our customers through the use of technologies that optimise gas consumption and processes." Schluep concludes.

Chris Phillips, sales and marketing director for South Africa adds: "These innovative supply solutions ensure that Air Liquide remains the leader in creating sustainable value for our customers in today's dynamic business environment – driving our performance to the next level."

The development of an industrial robotic **LSND welding system**

R O'Brien, Gestamp Tallent; W Veldsman, BOC Gases; and D Baglee, University of Sunderland.

Presented at the IIW International Conference in Helsinki, Finland in July, 2015, this paper describes the development and practical testing of a low stress, no distortion (LSND) welding system that uses solid phase CO_2 'snow' to cool GMAW welds immediately behind the weld seam.

The welding of sheet metal is often problematic because distortion of thin sheet is a common phenomenon resulting from the welding process. Current practice is to correct for this distortion using a variety of methods, which carry consequences.

The application of local cooling near to a weld during welding, referred to as dynamically controlled low stress no distortion (DC-LSND) welding, is known to reduce distortion. However, this process is yet to be established in industry due to a range of practical issues. To promote adoption of the approach, it is desirable to have the welding process and the cooling on the same side of the joint. However, in bringing the cooling to the same side as the welding process for gas metal arc welding, GMAW, the cooling must not interfere with the welding arc or the gas shielding or the quality of the weld will be impaired.

For this work, configurations to overcome such challenges and establish weld process conditions for low distortion welding in sheet metal have been investigated. A prototype industrial LSND welding system has been manufactured and integrated into a robotic welding system, which has allowed single sided, high quality, reduced distortion welding in a production environment when applied to both sample and real component geometries. Results from early industrial trials, on samples and real automotive components manufactured from high strength low alloy (HSLA) steels, and an evaluation of the system are presented and discussed.

Introduction

In today's manufacturing environment the welding of sheet metal is often highly problematic, primarily because distortion of thin sheet is a common phenomenon resulting from the heat of the welding process.

Some practical techniques to prevent and control welding distortion are those such as welding sequence planning, presetting to counteract distortion, minimising welding time and post processing operations [1]. However, increasingly, manufacturers wish to move away from the more post-weld rework and correction methods to in-process or active methods [2].

The reason for this move can be explained by considering typical examples: The use of additional operations or rework (such as heating or mechanical straightening), are expensive and wasteful; or over-designing to resist distortion, such as by adding stiffeners or increasing sheet thickness, which lead to increased weight and therefore greater fuel consumption in transport applications [3].

The application of local cooling near to a weld during the welding process, referred to as dynamically controlled low stress no distortion (DC-LSND) welding is known to reduce distortion [4]. The DC-LSND welding process makes use of a local cooling source following the welding arc to cool the weld, reducing the induced stress and distortion. However, the detailed physical mechanisms had not been sufficiently understood for this approach to be established until relatively recently, when more detailed research has emerged on the mechanisms and consequences [5].

Further still, the process is yet to be employed commercially due to some of the practical limitations. The system developed in the production of this paper sets out to address these limitations. The process has been previously restricted to joints that can be accessed from both sides, so the cooling can be applied on the opposite side of the joint to provide isolation of the cooling medium and the welding arc or process [6].

To make such a process more generally applicable to a range of typical weld joint types, it is desirable to have both the welding process and cooling on the same side of the joint. This avoids the need for access to both sides of the joint, which in many cases is not possible due to the design of the product or the welding fixture.

However, in bringing the cooling to the same side as the welding process, for gas metal arc welding (GMAW), for example, to ensure the quality of the weld is maintained, the cooling must not interfere with the welding arc or the shielding gas. The project discussed in this paper has investigated the configuration necessary to establish weld process conditions for low distortion welding in sheet metal (up to 6.0 mm thick) when using the active gas GMAW process. This has allowed single sided high quality GMAW DC-LSND welding in a production environment to be demonstrated – for applications including robotic welding.

Background

A welding procedure is usually determined by productivity and quality requirements, rather than the need to control distortion. Nevertheless, the welding process, technique and welding sequence do influence the level of distortion. Special welding techniques have been developed which minimise, and in some cases, can in fact almost eliminate, distortion. Low Stress No Distortion, LSND, welding techniques can include thermal tensioning, auxiliary cooling and mechanical restraint, and have been of interest to the welding industry for some time. As far back as the late 80s researchers were reporting successes with systems applying cooling to the region of the weld. Although much of this work was using TIG welding, it was believed to be generally applicable to a range of welding processes [7]. Experimental data indicated that the stretching effect from cooling following LSND welding can control welding stress and that the same effect cannot be achieved with conventional welding using single point clamping jigs [8]. The LSND welding technique was also shown to be suitable for materials that are generally fusion-welded, with any heat source, and the resulting structures may be generally free from significant heat distortion [8].

Many welding distortion mitigation methods, such as secondary heating or thermal tensioning [9], [10], and mechanical tensioning or straightening [11], have been developed to eliminate welding induced imperfections, which are major concerns for the welding industry. For this purpose, several researchers have used trailing heat sinks during welding, via DC-LSND, to minimise the distortion, which was first demonstrated in the early 1990s [4].

The DC-LSND welding process utilises a cooling source following the welding arc to locally cool the weld with the aim of reducing residual stress and distortion. Usually this method is used to control welding buckling distortion of thin plates, where the compressive stresses developed during welding of these thin sections exceed the critical level of buckling stress. The longitudinal residual stresses from the welding process is significantly altered with the application of a trailing heat sink and residual stress remains below the critical buckling stress level and, as a consequence, the distortion from buckling is minimised. When welding thin steel plates with a TIG welding source, conventionally and coupled with a trailing heat sink at a fixed distance from the welding torch, with carbon dioxide (CO_2) as the cooling medium, it has been shown that the use of trailing cooling has achieved virtually buckling-free plates compared to conventional processes [12].

Furthermore, the most effective type of cooling source has been found to be a jet of coolant that follows the welding torch at a short distance. In comparing the effectiveness of various cooling media, the CO_2 snow jet was the best cooling source during welding, resulting in a significantly greater decrease in temperature and consequently distortion [5]. However, the CO_2 snow jet does have drawbacks, including instability and practical implementation issues, which have limited its application in real practical terms. Several researchers have also found that a shielding device is required between the cooling source and the welding arc to maintain arc stability, and various different solutions have been utilised to achieve this separation [5], [6], [13].

More recently some researchers have investigated the use of the active cooling process, DC-LSND welding, on DH-36 steel [14]. Here they reported extensively on the measured thermal profiles and distortion measurements. Their results also show that the application of a localised cryogenic cooling source trailing the welding arc can significantly reduce weld-induced distortion when used with the GMAW process – without adverse effect from the forced cooling on the weld microstructure.

Much of the published research work into using DC-LSND techniques has been focused on numerical modelling [15], [16], [17], developing equipment only for proof of concept trials and testing in a laboratory [6], [14].

Significantly, no fully implemented LSND system using cryogenics has been found to be in use in industry to date, and this project was initiated to attempt to address that gap by specifically developing a system for use on a robot, in an industrial environment, and including real world weld joint examples.

Equipment development

A prototype of an industrial LSND welding system was manufactured and installed in the prototype manufacturing facility at Gestamp Tallent Ltd, in Newton Aycliffe, UK. This was integrated into the robot-welding set-up, shown in Figure 1, along with all associated safety systems required for an industrial application.

Industrial trials were carried out to evaluate the system and the results have been used to further refine elements of the system for this and subsequent work. The results of this work have also been used to develop extended industrial trials to demonstrate the system in use on a robotic system welding real components and applications.

The cooling head was designed and manufactured, and over the duration of the project a number of equipment variants were developed and tested. The essential requirements for the cooling head are to provide a cooling jet of CO_2 of sufficient quantity to a spot at the required distance behind the welding arc. In this process, liquid CO_2 is required to be delivered to a point in the cooling spray nozzle that will convert the liquid to micro crystals of solid CO_2, and it is solid CO_2 'snow' that is directed to the targeted cold spot. When the jet of CO_2 snow impacts the hot surface of the weld bead, the energy required for sublimation extracts heat from the material of the weld and heat affected zone, converting the solid CO_2 directly to gas (sublimation). It is this relatively high latent heat of sublimation on the surface that is responsible for CO_2 being such a good and effective coolant in this application. It is even better than liquid nitrogen, which despite being liquid at -196 °C compared to liquid CO_2 at -78 °C, has only around half of the relative cooling potential.

This cooling process must be accomplished without disturbing the arc and weld pool so that weld quality is not compromised. Further, it is desirable to extract the CO_2 gas to prevent a build-up in the workplace, which could present a hazard to the workforce.

Figure 1: The LSND welding system mounted on a robot in the industrial trial facility.

Figure 2: Close-up of the cooling delivery head with coolant seal in place, and through head extraction.

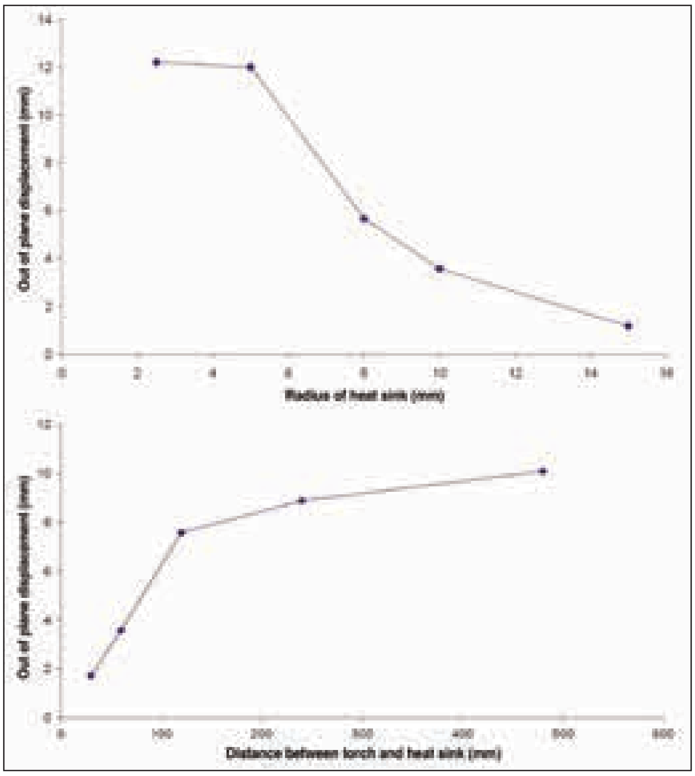


Figure 3: The results of a finite element study to investigate (a) the effect of varying cooling spot sizes at a fixed trailing distance (top graph), and (b) the cooling spot trailing distance at a fixed spot size.

The initial design of the cooling head included an air knife; an outer ring of compressed air that was designed to provide a barrier between the arc and the cooling gas. Initial trials with this arrangement were found to be ineffective, so this arrangement was discontinued.

Eventually, a seal was developed using a high temperature-resistant ceramic cloth, manufactured to form a tadpole shape. The bulb of the tadpole was filled with various high-temperature materials [18]. This could be adapted to create a full or partial seal, effectively protecting the weld pool and arc from the cooling. It was found to work effectively in many different joint configurations.

The sealing arrangement is shown mounted to the cooling head in Figure 2 and in situ, while welding in Figure 10. The cooling head with its matching nozzle was mounted behind the welding torch at a distance of 40 to 60 mm, depending on nozzle and joint configuration. Control of the CO_2 flow rate was achieved by a needle valve in the body of the delivery line and extraction was integrated into the cooling head.

The position and size of the cooling spot was investigated and optimised using finite element analysis (FEA) to simulate the welding and cooling process. This showed that the effect of cooling decreased as the distance of the centre of the cooling spot from the weld pool increased, to a point where it can be regarded as ineffective at around 120 mm of separation. The simulation also showed that, for a fixed cooling distance, a larger diameter of cooling spot helps to suppress high temperatures in the vicinity of the weld, and that below a diameter of around 10 mm, the advantages gained from the cooling process tend to disappear, probably as a result of the surrounding heat in the heat affected zone.

Thus, it is best to have a large diameter cooling spot, relatively close to the welding torch. These factors were incorporated into the design of the cooling head. The results from the finite element study can be seen in Figure 3, which shows the effect of varying cooling spot size at a fixed trailing distance, and cooling spot trailing distance at a fixed spot size.

The total LSND system integrated to the robot and welding system and torch, with the specially designed integrated cooling and extraction head, comprises in addition:

- A liquid CO_2 storage cylinder.
- A cabinet containing solenoid valves and phase separators.
- The electric control cabinet.
- A solenoid valve close to the cooling head.
- A CO_2 monitoring/safety shut off system.
- Delivery and extraction pipework.
- An extraction pump and control cabinet.

The control circuit and solenoid valves ensure that liquid CO_2 is delivered to the cooling head. The cooling delivery system also incorporates a start-up and shut down procedure, which involves a preliminary gas purge, to ensure consistent flow and avoid icing issues in the delivery system and nozzle.

Investigations and results

Initially, bead on plate weld trials were carried out on flat plate samples of thin sheet high strength low alloy (HSLA), steel typical of that used in the automotive industry (EN10149-2 S355MC). This was to ensure the process was working correctly and to demonstrate the application of the system set up on an industrial robot. The parts were welded using the active GMAW process with a 1.0 mm diameter ESAB 1251 steel welding wire and a shielding gas mix of 90% Ar with 10% CO_2. Plates were clamped in the welding fixture, supported by point contact on the underside. The cooling head was set up to be as close to the weld pool as possible, based upon the results from the FEA simulation model as discussed previously. Welding parameters were then established to enable a bead to be deposited without burn through of the parent material.

The welding parameters were typical of those used in a production setting. Welding trials were carried out with and without cooling, using various arrangements of nozzle sealing to optimise the process of retaining the CO_2 gas for

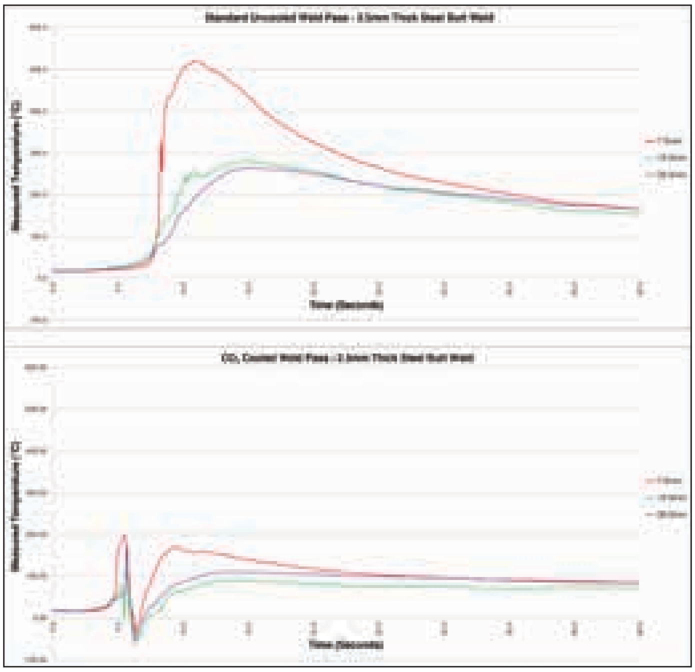


Figure 4: Temperature plots for 2.5 mm material welded at 650 mm/min using the robotic LSND system: (a) conventional (top graph), without cooling active; and (b) cooled (lower graph) using the DC-LSND with CO_2 snow.

extraction and to minimise interference with the welding arc and weld pool.

Thermocouples were attached to the underside plate material, positioned at 7.5, 15 and 20 mm from the weld centreline, and bead-on-plate tests conducted. By attaching the thermocouples to the underside of the plate they were protected from being ripped off by the cooling head or direct impingement of the CO_2.

The welding trials were carried out with and without cooling, using the cooling arrangement shown in Figure 1 and 2. Sample results from the thermocouple study can be seen in Figure 4, which shows the effect of the cooling on the temperature profiles.

Further, a comparison of weld macro sections shows that the welds from both conventional and LSND processes exhibit similar cross sectional shapes, bead widths and heights, as well as comparable levels of penetration. The two macro sections can be seen in Figure 5.

Representative samples were then measured for distortion using a Faro arm measurement system and macro sections taken to review weld quality. Typical sample distortion results for the bead on plate specimens are illustrated in Figure 6, which clearly show that a reduction in distortion of between 40-50% is achievable with the system in the trial. The typical results for bead on plate samples are illustrated as a simple visual side-by-side comparison as shown in Figure 7.

The microstructure examination of samples from both weld methods showed the resulting microstructure to be very similar. And when the micro-hardness was also checked by traverses across typical sample welds, the results from similar populations where not significantly different.

Once a reliable system was established, the trials were repeated using simplified 'real' joint conditions using the robot mounted DC-LSND welding system. Trials were carried out on butt welds in 2.0 and 2.5 mm thicknesses in XF350 steel plates, and on a 'top hat' section in 2.5 mm steel, with both 2.0 mm and 2.5 mm closer plates; this condition being chosen as it is representative of many of the weld joints used in automotive products.

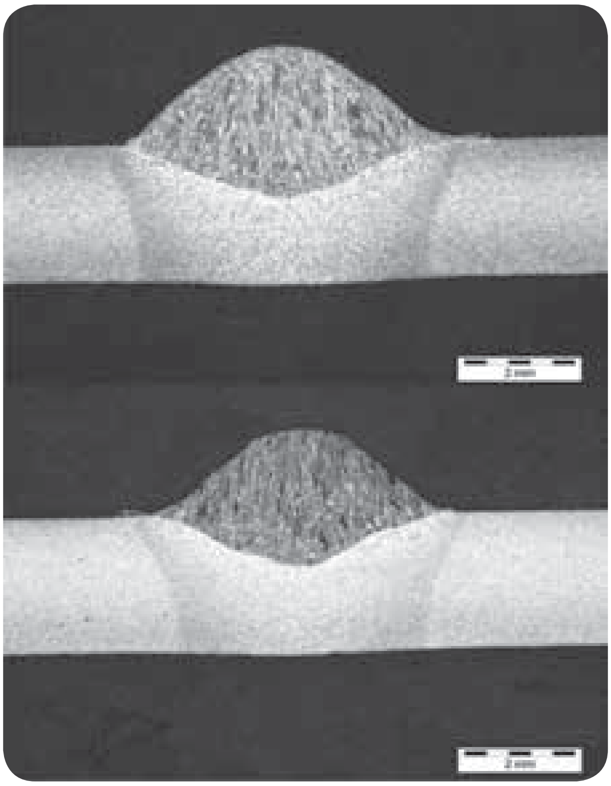


Figure 5: A comparison of macro section results for conventional GMAW weld (top); and the LSND process weld (below) for typical bead on plate sample welds.

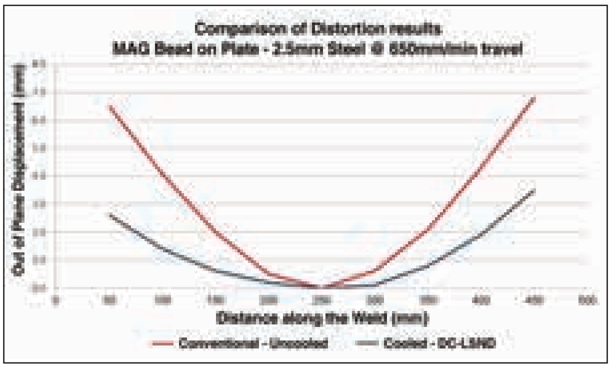


Figure 6: A comparison of the out of plane distortion measurements in typical sample welds.

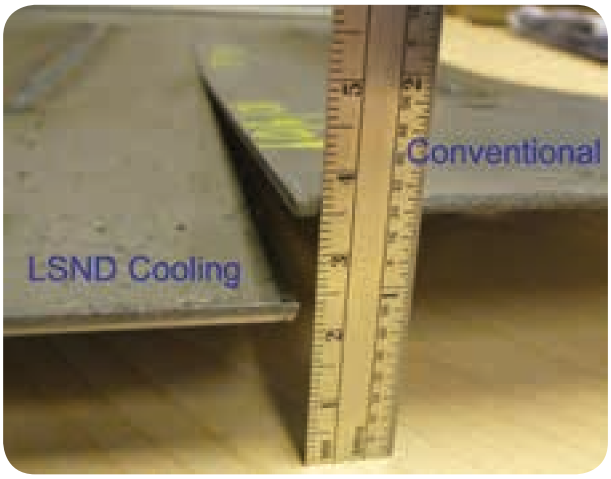


Figure 7: A visual comparison of distortion in typical sample bead on plate welds.

Representative samples were then measured for distortion and macro sections taken to review weld quality. It can be seen in Figure 8 that the macro section from the LSND weld exhibits a shape and dimensions almost identical to those observed in normal GMAW weld cross sections. The penetration of the weld is comparable to standard and it shows good fusion into the parent material. The visible heat affected zone is slightly narrower than observed in similar welds produced using the conventional GMAW weld process.

Furthermore micro-hardness across the weld was tested to ensure that it was giving a similar hardness profile to that seen in the standard GMAW welding of similar joint configurations. The locations of the hardness measurements taken on a typical LSND butt weld macro are also shown in Figure 8(a), and the corresponding hardness results reported in the table of Figure 8(b).

The hardness was measured using a 300 g load and taken at 0.5 mm intervals across the weld. This was done approximately perpendicular to the fusion line to characterise all regions in one traverse across the weld. Again these figures show that the weld is very similar in its properties to those of a standard GMAW weld produced on the same equipment with the same settings. The butt weld samples exhibited similar levels of reduction in overall distortion to that previously observed in the bead on plate samples.

A simplified 'top hat' section, which was representative of a typical automotive structural cross section, was used to further investigate the performance of the system, in particular, those with more challenging access conditions. This is shown in Figure 9, and manufactured from 2.5 mm HSLA steel with yield strength around 350 MPa.

Sample sections were also produced using combinations of 2.0 mm and 2.5 mm steel to the same specification. Similar sections are welded using conventional robotic welding systems in high volume production in the automotive industry. There, distortion can cause fit-up problems when other components, such as brackets or sub-assemblies, are welded to the base section in subsequent operations, as well as giving rise to other dimensional issues.

Figure 10 shows the system in situ at the start of the top hat weld showing the seal developed to ensure the separation of the cooling from the welding arc.

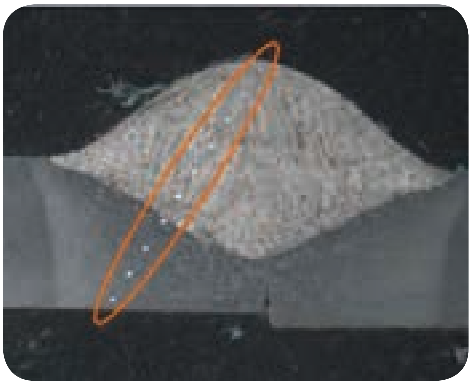
With the top-hat component, the distortion was quite low over the 500 mm sample part used for the trial; the part effectively having two lap weld runs in opposite directions, one either side of the top hat along the full length of the sample section.

A typical example of the distortion measurements recorded using laser scanning is shown in Figure 11. The relatively stiff nature of the top hat section to resisting the weld distortion due to buckling means the overall distortions are very low. However, the cooling has a positive effect in reducing distortion, which can be seen in the graph of measured results along the centreline of the closing plate shown in Figure 12.

Following successful trials on the sample components further tests and evaluations have been carried out on real production components to begin to investigate the necessary improvements to the system and to enable it to be applied to more general geometries.

The system developed here was used to successfully produce cooled welds on both bumper beam and axle components that are of a satisfactory quality, being comparable in these respects to standard welds. It should also be noted that these products include welds that have non-straight weld paths and components with complex form and fit up, ie, the trials were not limited to flat plates, butt welds and simple lap joints.

A bumper beam was identified for some of the real com-



Hardness traverse		
Location		Hardness
1	Weld	226
2	Weld	226
3	Weld	232
4	Weld	232
5	Weld	233
6	Weld	231
7	Fusion line	196
8	FL + 0.5	176
9	FL + 1	174
10	FL + 1.5	171
11	Unaffected Parent	155

Figure 8: Macro section of a butt weld, in 2.5 mm XF350 material (150×500 mm plates), produced using the LSND welding process, showing: (a), the locations of indents for micro hardness test; and (b), a table of associated micro hardness results across the welding zones.

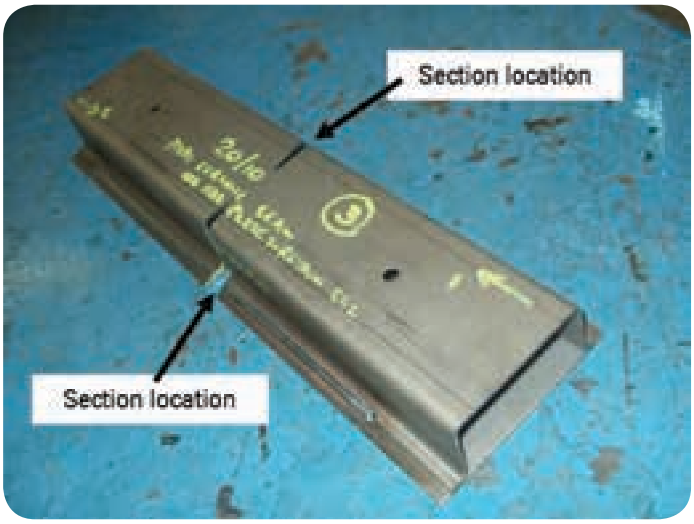


Figure 9: The top hat with its overlap weld joint configuration (welded both sides of the top hat) produced using robotic same-sided LSND welding. The section location taken for the weld macro study are also shown.

Figure 10: The LSND welding system, with coolant seal in place, in situ on a top-hat weld joint shown trailing the robotic MAG welding torch.

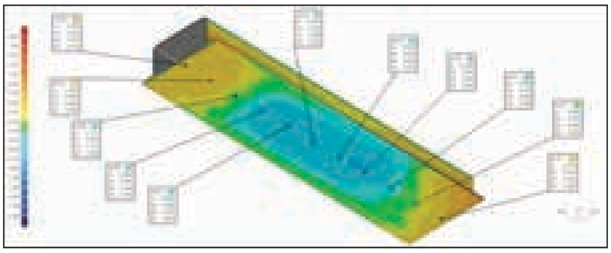


Figure 11: A point cloud comparison to laser scanned results of distortion measurements for the welded top-hat section.

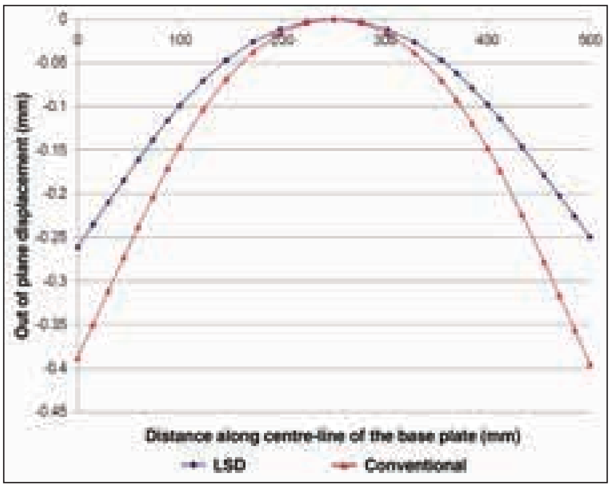


Figure 12: A comparison of the measured out of plane distortion on the centreline of the closing plate for the top-hat section.

Figure 13: Images of the trial bumper beam sub-assembly showing the weld pattern used for the trials.

ponent trials as shown in Figure 13. The weld paths to be welded comprised four long straight welds that join the upper and lower pressing for this product. These welds are actually stitch welds in production, but for the purposes of this trial the weld lengths were extended to magnify the distortion effects.

The current production product is known to suffer high levels of distortion and production operators report that once the main beam has been welded and then removed from the weld fixture, the final resultant distortion is such that it could not be placed back into the same fixture once cooled. The upper and lower pressing panels for the bumper beam are both made from 2.0 mm steel to XF350 material specification.

The weld path was straight for each of the four welds used for the trial; however these are located in an area of significant form in the pressings and, therefore, would test the robustness of the seal arrangement to conform to the part profile. A robotic program was developed to carry out each weld immediately

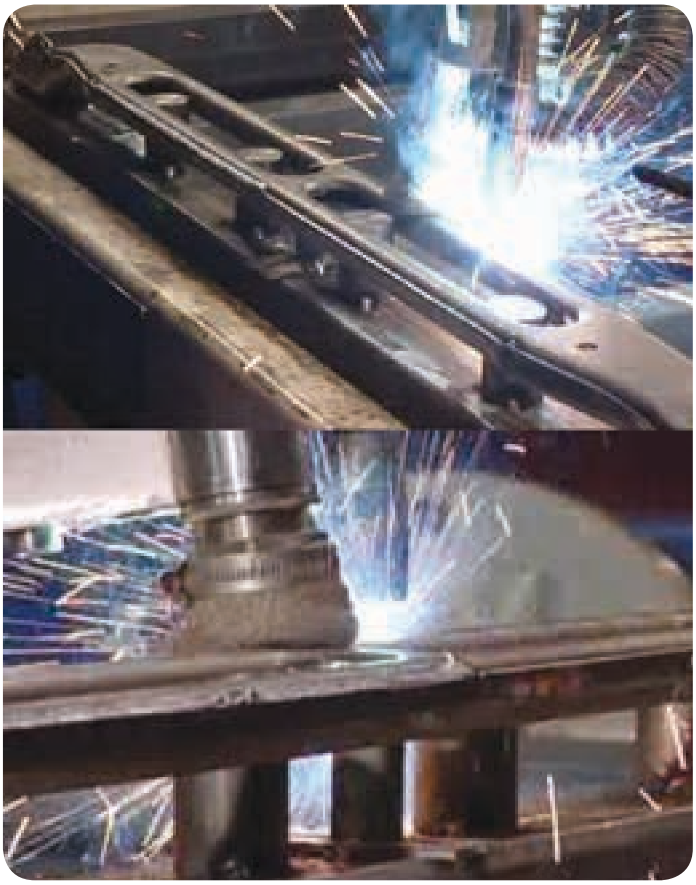


Figure 14: The LSND welding head in position on the axle component during testing of the coolant sealing and the weld path.

after each other, as would be done in a production situation, switching the coolant on when the arc started but also keeping coolant on until the cooling head had completely traversed over the weld stop location so as to cool the full length of the weld run. The coolant was switched off whilst the robot traversed at speed to the next position to start welding, this was controlled via the robot program with the coolant control panel being interfaced with the robot controller.

During set-up of the robot program, trials were conducted on the beam using the standard GMAW process, where a fixed block was used to observe the movement of the part under welding. To do this, the part was welded in a fixture that only had end restraint on the lower panel.

When welded using conventional GMAW processes, the beam was observed to distort towards the fixed block at the side of the part by up to 6.0 mm at a certain stage during welding and away from the block by 5.0 mm at others, illustrating the magnitude of and distortion problems associated with welding such slender parts. This in fact meant that, at certain stages of the program, the weld torch was significantly off the weld seam, at times burning into the wall of the pressings and at other times missing the part altogether as the part distorted towards and away from the torch.

To ensure such problems did not happen in the trials the fixture was built to restrict the movement of the part during the welding process and to ensure that welding would always remain on the path of the weld seam. In order to maintain a consistent weld joint fit-up gap and position, the upper and lower panels were tacked together by hand using small tacks.

The weld paths were developed in the robot program and the sealing position of the cooling system optimised to ensure it followed the weld path whilst maintaining a good seal to

Figure 15: A comparison of the effect of distortion on repeatability and weld quality on typical LSND (top) and conventional GMAW welded (bottom) beam parts manufactured in the trial. It can be seen that the induced distortion in the conventionally welded part causes the weld path to drift off the seam.

Figure 16: A comparison of the visible HAZ on typical LSND (top) and conventional MAG welded (bottom) beam parts manufactured in the trial.

the joint to prevent disruption of the arc. The orientation of the torch and cooling head is shown in Figure 14, illustrating the part being welded using the robotic LSND welding system developed. The second image in this figure clearly shows that the seal is working effectively to contain the CO_2 and to allow through head extraction of the gas after sublimation of the CO_2 snow cooling to the hot surface of the weld bead.

Visual inspection of the trial parts after welding from both the LSND process and the standard GMAW process revealed significant differences in the distortion patterns. This examination, as shown in Figure 15, reveals that the distortion occurring in the standard weld part has caused the assembly to move relative to the pre-programmed robotic weld path, and effectively the weld is off seam.

This effect begins to appear from about half way along this weld and gradually moves further off toward the end of the weld (the point closest to the camera). This is not the case with the LSND weld, which results in a stronger, more consistent and better quality weld

It should be noted that the holding fixture did have a small lateral clearance to allow the parts to be assembled, which made movement possible. It was designed with some clearance to ensure that any distortion would not cause the part to become stuck in the fixture.

The differing effects of the two welding processes were also evident in the magnitude of the heat-affected zones being displayed on the surface of the parts. It was clear to see the material phase-change regions (HAZ) due to the effects of the welding on the part and these were considerably smaller on the LSND part than the standard GMAW welded part. This can be seen in Figure 16, where the two parts are compared next to each other. In Figure 16 the part to the top of the image being a LSND part and the one in the lower half being a conventionally welded part.

The levels of distortion seen in the part are apparent to the naked eye, and therefore it is straightforward to do a quick visual assessment of the parts to compare the differences in distortion.

Bending of the part occurs along the length of the component when moving towards the centre from the stiffer outside sections. In addition there was some twist occurring in the parts. It could be seen that the GMAW-welded part exhibits a significantly higher level of bow and twist than the LSND part. The difference in twist was hard to accurately quantify using simple measurements; however the reduction in bowing could be estimated to be reduced by around 3.0 mm, with a peak bow on the conventional part being in the region of 10 mm.

The majority of the distortion occurred while the part cooled after it was removed from the fixture. It should also be remembered that the level of distortion occurring in the conventional part, before removal from the fixture and during welding, was such that some of the welds were produced off-seam. This was not the case when welding using the LSND process.

Discussion and conclusions

A prototype robot mounted DC-LSND GMAW system with a cooling head and welding torch on the same side of the welded joint has been integrated and demonstrated successfully in an industrial facility.

Welds have been produced with acceptable weld quality with no significant metallurgical discrepancies when compared to standard samples. Distortion has been reduced by up to 40%-50% on simple components. The system has been shown to successfully overcome any disruption of the welding arc and GMAW process when the cooling is applied to the same side of the weld joint with the cooling delivery system close behind the welding torch. Although further work is required to optimise the configuration and design to suit more generalised complex 3D weld profiles.

Repeatability of the welding results on butt welds and simple profile joints and sections has been demonstrated. The process has been successfully applied and demonstrated on a number of real component example geometries, although further refinement and development of the system would be required for full production and acceptability in a general industrial manufacturing environment.

Acknowledgements

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Pipeline welding:
raising the technology bar

On October 21 and 22 in Midrand, Lincoln Electric South Africa hosted a series of Pipeline seminars by global pipeline welding specialist, James Lamond (right). *African Fusion* attends and reports.

Setting the tone for the day, Lamond says new pipeline welding equipment, processes and materials can have a major impact on the success and profitability of pipeline construction projects. "But to succeed, contractors have to know exactly what they are dealing with, particularly with respect to materials of construction and the strategy chosen by the client. Poor understanding and organisation can have serious and expensive consequences," he warns adding that, through real pipeline successes and strategy decisions, he aims to challenge current thinking and to introduce available welding options that can significantly improve productivity and profitability for pipeline contractors.

Showing some real footage from 2013 of a pipeline under construction in Poland, he says that Lincoln Electric offers the full range of processes and consumables and is a trusted construction partner for pipelines all over the world. "This X70 pipeline is being constructed at temperatures of -20 °C in snow and ice. With the higher strength steels, a new modern challenge has emerged, in that the consumable has to overmatch the strength of the X70 pipe material, which demands that the exact material properties of the pipe are known," he says.

Explaining further, he says that this overmatching strategy is being adopted where seismic movement of the ground may cause excessive strain on an in-service pipeline. "The challenge that arises is that the tensile and yield strength specifications for the different pipe material grades overlap significantly. An X65 material, for example, is required to have a tensile strength of between 450 and 600 MPa, while an X80's tensile strength must be between 555 and 705 MPa. A steel specified to X65 with a strength of 565 MPa, therefore, can have a real tensile strength that also complies to X80 specifications," Lamond explains. "So to overmatch the consumable, the contractor has to know exactly what material he is dealing with. The materials specification, alone, is not enough," he adds.

Lincoln Electric welding specialist, Josef Henning, demonstrates the STT (surface tension transfer) welding process for root pass pipe welding. Inset: The resulting STT weld bead has excellent penetration, a 4.0 mm bead thickness and a uniform flat profile that removes the need for grinding or an additional hot pass.

Turning attention back to the pipeline video, he says: "Successful pipeline welding is done as a well-organised procession. All the equipment is set up in portable work station tents, first for root welding and followed by filler passes," Lamond says. The video shows pipes being aligned using an internal clamping system – "to achieve high/low bore matching of within 2,0 mm" – and a crane immediately lowers a tent over the new pipe joint. "The root pass on this pipeline was inserted by two welders using Lincoln's solid wire STT (surface tension transfer) welding process. 90% of those who go bankrupt fail at this stage. Root jointing of pipe sections should take three minutes. If, due to fit up issues, bad organisation or excessive grinding, you have too may bad days and not enough good days on a pipeline project, you are inviting 'le catastrophe', as they say in France," he warns.

Showing two welders completing a root pass in real time – 2 min 43 sec – Lamond adds that each welder usually makes only one stop/start on his half of the root, at around the 4:00 position where he repositions to complete the overhead section. "This is to reduce the amount of grinding required. Grinding takes time and time is money. On a good day, only the stop/starts need grinding and if any more grinding needs to be done, then warning signs should be flashing," he suggests. "If just two minutes per root weld is added for grinding, three fewer pipe sections will be added to the pipeline on that day," he says.

Once completed, the root welding team picks up the tent and moves to the next joint and a second tent is placed to fill the joint. On this pipeline in Poland, two Bug-O Piper Plus mechanised welding systems were used with Outershield 91K2-HSR flux-cored welding wire. "This is production welding. Two Bug-O's are being used at the same time on the same pipe ring. Note the torch angle, which is set at a 5.0° lag, so that in all positions, the welding arc pushes the slag to the front of the weld pool, preventing entrapment," Lamond points out.

Returning to his presentation, he reveals that, in Africa, some 22 000 km

Above: A Bug-O Piper Plus mechanised welding systems ready for use. These systems are commonly used with Outershield 91K2-HSR flux-cored welding wire for fill and cap passes. Right: Lincoln Electrics' Power Wave S500 with the addition of an STT® Module has the fast digital communication necessary for controlling the root welding process for consistent penetration and bead profile.

of pipeline – in Mozambique, Tanzania, Nigeria, Namibia, the Congo and more – are currently being planned. "As in all parts of the world, Africa faces shortages of skills; rising labour, material, and energy costs; a decrease in the world oil price and intense competition. In addition, more stringent quality demands are being applied for the higher strength pipe steels, which demand that old construction practices be updated," he says.

"Conventional stick welding is still OK for some applications, and these processes have remained unchanged for over 40 years – but well-established practices must be followed and complacency has to be avoided!" he exclaims.

Stronger pipeline materials, such as the X70 and X80 grades are driving the industry away from the use of cellulosic stick electrodes, which are associated with high hydrogen content. "When we reach X70 properties, in terms of real strengths, then the family of low-hydrogen stick electrodes, called Pipeliner LHD should be considered due to their low hydrogen levels (less than 5.0 ml) – and these are also specified when wall thickness is greater than 12.7 mm.

"Low productivity, however, associated with the use of stick electrodes, poses serious risks and challenges, which is driving a trend towards the use of semi-automatic and mechanised welding," says Lamond.

"Productivity on a pipeline project is all about operating factors, the ratio of arc time to non-arc time. When stick welding, along with stop/starts and stub losses, a significant amount of grinding is required between passes.

"A cellulosic root pass has a concave top surface that must be ground flat before applying the hot pass. This can result in a 1.6-2.0 mm fusion layer, and in worst-case high/low mismatch of more than 2.0 mm, grinding can remove the root – and the welder has no way of knowing when this will happen. These are the productivity risks that tend to drive the adoption of the more mechanised processes," he suggests, adding that the use of modern root welding processes such as STT is twice as fast as cellulosic welding, because neither grinding nor a hot pass are required.

STT + flux-cored wire

By adopting more modern technology, such as the use of Lincoln's STT process followed by mechanised flux-cored welding, operating factors on pipelines can be increased to between 60 and 70 %. "You need to respect the welders to achieve these results, but high productivity levels are no longer exceptional and do not require massive levels of investment," Lamond assures.

Both of these are gas-shielded processes, so they do not like windy conditions – hence the tent. Being low hydrogen processes, gas shielded methods can tolerate lower levels of pre-heat and the deposit generally has very good mechanical properties. "While good skills levels are required for STT root welding, fewer welders are needed and welders can easily be trained to use the process effectively," he adds.

Benefits of STT, according to Lamond, include:

- Reduced training time: It is difficult to find experienced highly skilled welders, especially for the critical root pass. STT offers ease-of-use, resulting in shorter training times compared to other welding processes.
- Lower repair rates: STT minimises the most common defects.
- Low smoke and spatter: STT uses high frequency inverter technology resulting in high quality welds with less spatter and fume generation.
- The process makes it easier to perform open root welding on pipe with better back bead profiles and edge fusion: The STT process is designed to allow surface tension to 'suck' the weld bead into an open root gap of around 3.0 mm. The resulting weld bead has a uniform flat profile with a higher alignment measurement (4.0 mm) than standard cellulose electrodes (1.6 to 2.0 mm). The flat STT profile removes the need for grinding and no hot pass is required. This makes it possible for the root welders to move on immediately after completing a singe pass.
- The thicker nugget also reduces the risk of bead shrinkage or 'suck back'.

"Semi-automatic processes place the welding controls into the welding system instead of in the hands of the welder. But skilled and knowledgeable people are still needed, to insert the root welds and to tend the mechanised processes, for example. On a pipeline, every single welding joint is different. Welders are under-rated and, because of their ability to react the variations they see, they keep many engineers out of trouble," Lamond says.

Nickel-based FCAW and LNG storage tanks

In this article, Ben Altemühl of voestAlpine Böhler welding highlights the costs and productivity advantages of using nickel-based flux-cored wire for the welding of LNG storage tanks in 9% Ni steels.

Welded joints in the fabrication of cryogenic liquid nitrogen gas (LNG) tanks are submitted to severe conditions – such as very low temperatures and high stress. Welding of these joints comes with stringent requirements on weld metal strength and toughness. Products from voestAlpine Böhler Welding offer high quality solutions for commonly applied alloys such as:

- 9% Ni steel.
- Austenitic steel with cryogenic properties.
- Low-temperature construction steel.
- Aluminium

The voestAlpine Böhler Welding portfolio for welding of 9% Ni steel covers all commonly applied processes (SAW, SMAW, GMAW and FCAW).

To obtain the required properties with 9% Ni-alloyed consumables for welding 9% Ni steel, however, is impractical because an accordingly complex and costly heat treatment is necessary. Only nickel-based weld metal can match the strength of the steel with good ductility at LNG service temperatures of about -170 °C in the as welded condition.

An additional advantage is that nickel-based consumables reduce the risk of hydrogen induced cracking, as they deposit an austenitic weld metal. Basic SMAW electrodes and SAW fluxes are used, which give a clean deposit with very low levels of micro slag inclusions.

Typical requirements for welding consumables are given by API 620 Appendix Q, ASME/AWS and BS 7777. These specify strength levels of $R_{p0,2}$>430 MPa and R_m>690 MPa, while project specifications for Charpy V-notch (CVN) impact toughness can be greater that 70 J at -196 °C, with lateral expansion greater than 0.38 mm. In addition, CTOD (crack-tip opening displacement) fracture toughness values may be specified for resistance to crack lengths down to 0.3 mm at temperatures of -170 °C.

Mechanised flux-cored wire welding with the UTP AF 6222 Mo PW wire and (left) a typical high quality joint.

Welding processes

The SMAW process is generally used for welding joints in the 3G and 4G position on large LNG storage tanks and for most welds on smaller tanks. For welds that can be completed in the 1G and 2G positions, the submerged arc welding process is used because it offers much higher deposition rates.

Flux-cored arc welding may be used for manual welding in the 3G position, but FCAW can be significantly more productive and cost efficient when applied using a mechanised process, as highlighted below.

Welding practices

Preheating of 9% Ni plate with thickness below 50 mm is not required. However, to remove any moisture from the welding area, a preheat of up to 50 °C is strongly recommended. Subsequently, the interpass-temperature needs to be held below a maximum of 150 °C. The heat input should not exceed 2.0 kJ per mm and, ideally, should be around 1.5 kJ per mm. Alternating current (ac) welding is generally recommended for the SMAW and SAW welding processes to avoid arc blow, and must be used when residual magnetism in the plate is high. Welding with ac current also results in higher weld metal toughness properties and ac can also be considered for FCAW.

Efficiency of the different welding processes is calculated by dividing the arc time by the available working time and is expressed as a duty cycle. The welding duty cycle depends on several non-welding operations that are required when completing welded joints:

- The time needed to prepare for welding.
- The time required for grinding, deslagging and cleaning of the weld.
- The time required for wire and machine tending.

In general, average duty cycle values for the manual welding processes are:

- SMAW 10-20%
- GMAW/FCAW 15-25%

With mechanised GMAW/FCAW welding, the duty cycle can be raised considerably and ranges from 25 to 40%. Reasons for this include:

- Fewer starts and stops need to be ground out compared to manual welding and slag can be removed during welding. Post weld cleaning work is therefore minimal.
- Welding is continuous. The welder does not have to reposition himself and will get less fatigued during welding .
- Mechanisation reduces welding defects, such as lack of fusion, which results in less additional processing time for post-weld repairs.

As with all mechanised welding processes, the following factors can negatively influence the duty cycle:

- Uneven joint preparation requiring welding parameter adjustments for the root run.
- Badly performed back grinding or gouging of the joint, resulting in parameter modifications for the fill passes.
- A work place that is not suited to mechanisation.
- A welder who is not very experienced with mechanisation

Nickel-base flux-cored wire

The nickel-based flux-cored wire UTP AF 6222 Mo PW (alloy 625-type with classification AWS A5.34 E NiCrMo-3 T1-4) is used for optimal productivity in positional welding. Its excellent weldability in the vertical-up position is due to the fast freezing slag that supports the weld pool, while enabling spray arc welding for enhanced productivity. The wide parameter box makes it tolerant to arc fluctuations, which is excellent for mechanised welding using standard welding automation. The slag is easy to remove, the weld has a nice appearance and there is no need for post weld grinding.

UTP AF 6222 Mo PW weld metal meets all applicable specifications and standards for the welding of 9% Ni steels, as shown in the table of mechanical data for a 28 mm thick joint in 9% Ni steel. Standard GMAW equipment can be used, with or without weaving of the welding torch, and the wire is designed for use with standard Ar/15-25% CO_2 shielding gases.

Manual shielded metal arc welding (SMAW) in the 3G position using UTP AF 6222 Mo PW and (right) a typical joint.

The key benefit of this flux-cored wire lies in the high deposition rate compared to SMAW when applied in the same vertical-up welding application. The deposition rate is up to three times higher. This feature, combined with the low defect rate and consistent joint quality, makes FCAW a welding solution that can shorten fabrication times considerably for typical LNG applications.

Cost savings with FCAW compared to SMAW

Further economical savings with FCAW compared to SMAW are gained in consumable consumption by weight. SMAW electrode efficiency is decreased by about 35% due to stub end losses, slag and spatter, whereas only 15% is lost in slag and spatter with the FCAW process.

A calculation involving a typical 10 m joint length with an X-preparation in an LNG tank is shown below, calculated with the help of the Welding Calculator, available on the voestAlpine Böhler Welding website. Based on these entries the calculator generates the required quantity of product to realise the weld.

The deposition rates and quantity of product needed for a NiCrMo-6 type stick-electrode with an efficiency of 150% and for flux-cored wire welded with corresponding current in the 3G-position are:

With 3.2 mm NiCrMo-6 electrodes:

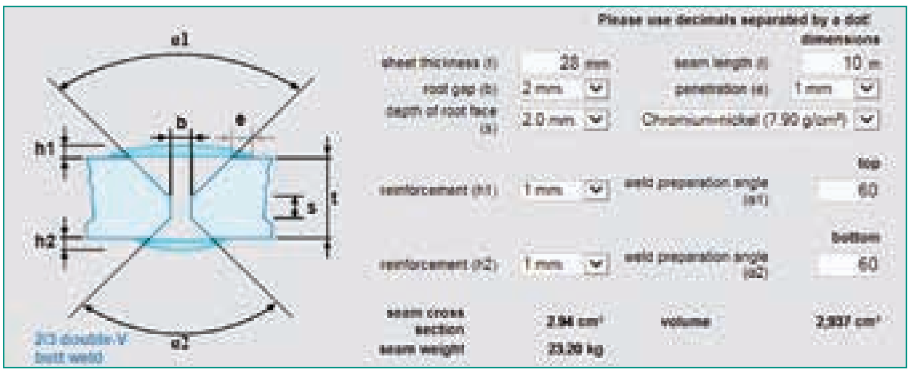
- Deposition rate: 1.5 kg/h;
- Consumables used: 812 pieces or 39 kg of product.

Flux cored wire 1,2 mm:

- Deposition rate: 3.6 kg/h
- Flux-cored consumable used: 26.68 kg of product

For welding this joint, 62 hours are needed for SMAW (with a duty cycle of 15%), whereas only 25 hours are needed with FCAW (with a duty cycle of 30%)!

Because of the reliable mechanical values in 9% Ni-steel – and above all cost-savings – the flux-cored wire UTP AF 6222 Mo PW has been successfully used in vertical-up welding of 9% Ni plates in recent LNG tank building projects in the USA, Australia, South Korea and Europe.



A typical 10 m joint length with an X-preparation in an LNG tank is calculated with the help of the Welding Calculator, available on the voestAlpine Böhler Welding website. The calculator generates the required consumable quantity needed to complete the weld.

Fabrication for processing

In this article, Tony Paterson of the Wits School of Chemical and Metallurgical Engineering describes the special welding requirements for stainless steel piping in plant applications where bio-film build up on pipe contact surfaces has to be avoided. A mathematical algorithm was developed to assess interconnecting pipes against the criteria of a point-by-point minimum overlap of 80% around the pipe circumference.

Industrial plants subject to health and environmental regulations include food, dairy, pharmaceuticals, cosmetics, and beverage plants processing drinks such as beer and wine, where bacteria can be directly associated with bio-film build-up on product-contact surfaces. To meet the demand for greater plant hygiene, stainless steel plants were built in the mid-1960s, which had an intended life expectancy of 30 years and more.

Hygienic processing plants are typically fabricated from polished 304L or 316L austenitic stainless steel, although duplex stainless steels have recently been introduced. In line with regulations, plant design philosophy requires: free product flow without stagnation; protection from the external environment; and cleanable plant interior surfaces.

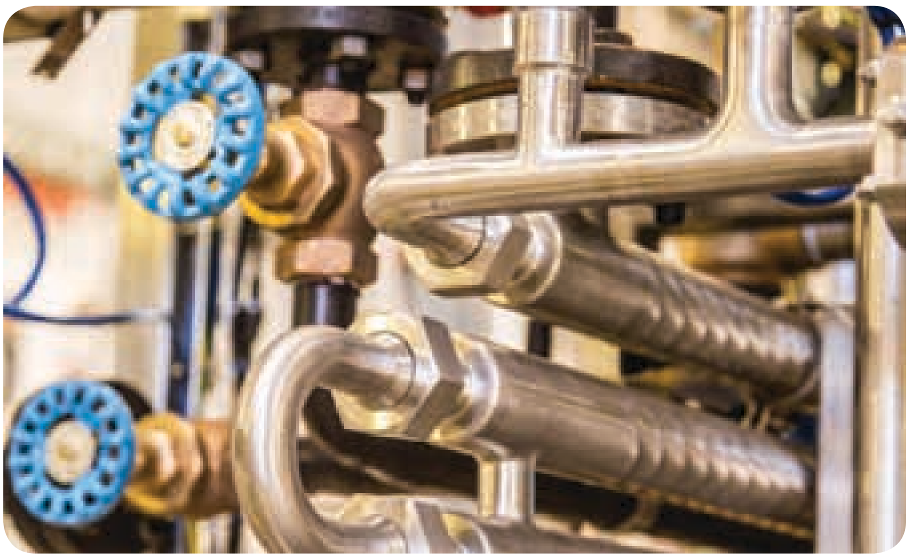
When fabricating plants, standard plates and pipes are formed and connected together, often by welding, into systems. Welding, an enabling technology, facilitates stress alignment of components and thus lighter structures. Whilst traditionally welding has always focused on structural integrity, hygienic welding introduces new challenges. These may prove more demanding than structural integrity, and are an addition to other operational requirements including environmental pressures.

Welded processing plants

Plants generally comprise a closed system of tanks, heat exchangers, mixers, distillation columns and interconnecting thin-walled pipes. Two parallel systems operate in tandem, one product-related, and the second to facilitate cleaning of the internal surfaces of pipes, vessels, equipment, filters and fittings without disassembly, known as clean-in-place (CIP). Up to the 1950s, closed systems were disassembled and cleaned manually but with CIP, cleaning is faster, less labour-intensive and more repeatable, posing less of a chemical exposure risk to people.

The welded area in a plant is a very small part of the total area of the installation. Fabrication and design detail, however, influence plant performance and cleaning processes, and can result in lost productive time.

Realistically, hygienic welded fabrication will be both challenging and costly. Although this puts capital budgets under pressure, well-designed and executed fabrication should ease operational costs.



Plants generally comprise a closed system of tanks, heat exchangers, mixers, distillation columns and inter-connecting thin-walled pipes. Photo courtesy BOC and A&G Engineering.

Factory and site welding

Whilst the major components in processing plants are factory built, many of the small-bore pipe inter-connections are made on site.

Factory conditions are easier to control as both sides of a weld are generally accessible. During welding of products accessible from both sides, protection of the tool side and the opposite side of the weld by an inert gas is required to avoid sensitisation. If carried out properly, the need for post-weld treatments (grinding, polishing, pickling and passivation) will be minimised.

Site welding is more difficult as, after fabrication, the system is closed as access compromises sterility of the equipment. The interiors of pipes are only accessible to fabricators for cleaning, gas purging and NDT inspection purposes. On-site welding is inherently more difficult to control, more difficult to monitor and more difficult to repair.

Inadequate welded joints compromise product quality in an otherwise hygienically designed plant because poor joints and/or welds will trap bio-film, thus encouraging bacterial growth. Bio-film volume increases with surface roughness, increased temperatures, lower flow speeds and stagnant areas.

Bio-film formation on inside contact surfaces of a plant can also exacerbate local galvanic activity and microbiologically induced corrosion (MIC). Alongside bio-film, MIC can significantly impact capital equipment life.

Welding effects include:

- Welding process-related roughness in the heat affected zone (HAZ).
- Possible sensitisation leading to roughness and corrosion attack (low carbon stainless steels overcome this).

plants subject to health regulation

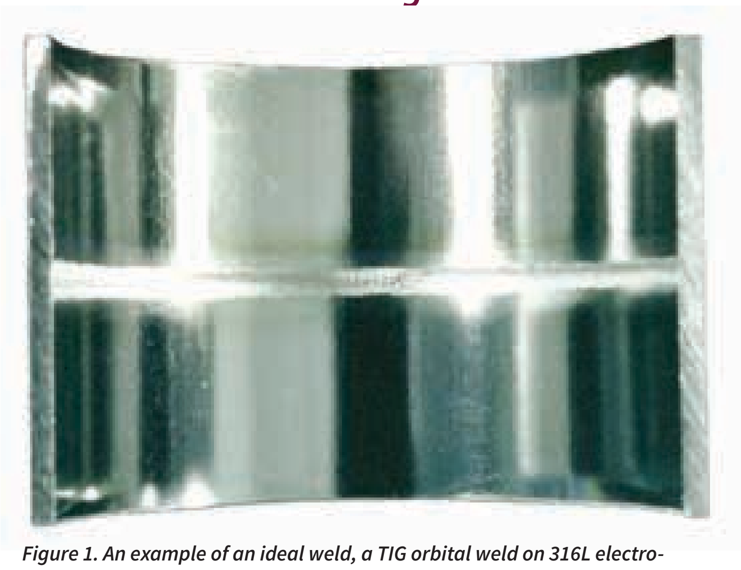


Figure 1. An example of an ideal weld, a TIG orbital weld on 316L electro-polished stainless steel pipe.

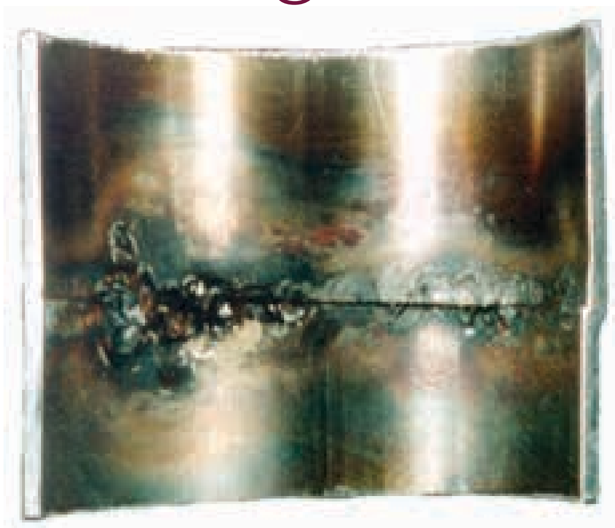


Figure 2: An unacceptable manual weld with defects including lack-of-penetration, misalignment, a crevice, and a poor ID purge.

- Heat induced oxidation in the HAZ (inert purging gas needs to be used).
- Geometric effects from misalignment and/or uncontrolled welding of root beads leading to stagnant regions.
- Cooling of heterogeneous filler metal leading to micro cracking.
- Pickling and passivating chemical treatments affecting surface roughness.
- Fit-up effects from poorly cut and/or aligned pipe-ends leading to local under or overfill.

Pipe welding

For pipework, the preferred fabrication method is automatic orbital welding as this is capable of producing consistently high quality welds. Process plants require a significant level of on-site assembly welding of small-bore thin-walled pipes, in particular. Welds on the product-contact side must be continuous; they must be smooth enough to allow proper cleaning.

Figure 1 shows an ideal welded joint, a TIG orbital weld on 316L electro-polished stainless steel pipe. The weld is fully penetrated with a uniform crevice-free inner weld bead showing good pipe-to-pipe alignment. The internal diameter (ID) was purged with argon.

To achieve this:

- Pipes must be dimensionally matched (within 20% by weight).
- Alignment, fit-up, orientation and cleanliness must be controlled.
- Weld procedure used is aligned with the sulphur % (Note changes and effect of changes in 316 composition limits).
- Tungsten geometry is diamond ground and correct.

Figure 2 shows a manual weld taken from an operating pharmaceutical plant. This unacceptable weld has defects including lack-of-penetration, misalignment, a huge crevice, and a poor ID purge.

Impact of pipe manufacturing and fabrication

Several factors lead to inadequate welded joints and pipe fabrication. One of these is pipe geometry. Pipes designed to be circular are often oval due to manufacturer inputs related to the rolling, slitting, forming, seam welding and cutting to length operations. Pipes are manufactured to diameter, wall thickness and ovality tolerances. These tolerances affect the matching and alignment of pipe-ends, which are otherwise correctly prepared. Whilst this is a matter beyond welder control, the fabricator can influence choices. In addition, fabricator centroid misalignment is important.

In the case of thin walled pipes, the impacts of tolerances on hygienic fabrication can be significant in terms of the increased CIP operations required to maintain an acceptable product.

To test the impacts of pipe manufacture on weld integrity, 90 × 316L stainless steel pipes and bends from the then current Okahandja brewery project in Namibia were measured by the fabricator in India. Maximum (major axis) and minimum (minor axis) external diameters and three equally spaced wall thicknesses were tabled. Of these 90 pipes, 27 related to 50 mm ID, 1.5 mm wall thickness pipes were analysed. These naturally fell into two distinct groups, one with tight manufacturing tolerances (ovality 0.04-0.07 mm) and one with wider tolerances (ovality 0.17-0.51 mm).

A Monte Carlo-based mathematical algorithm was developed to assess interconnecting pipes against the criteria of a point-by-point minimum overlap of 80% around the pipe circumference. (Orbital welding manufacturers prefer 95%). The algorithm included three parts: an external ellipse; an internal shape; and a random misalignment. The external ellipse was defined by the measured major and minor axes, and the internal surface by the external ellipse less the local wall thickness. This was modelled as a randomly orientated quartic function based on the three wall thicknesses taken for each specific pipe and the misalignment by allowing for a random 6% variation of wall thickness (0.1 mm).

Twelve pipe alignment situations were measured. Each involved 1 000 iterations. The minimum overlap for each iteration case was recorded onto a histogram.

The cases included: fitting one straight, high-tolerance pipe to another with no orientation control; and fitting one randomly selected, high-tolerance pipe to another with major axis alignment. The fit-up models were repeated using low tolerance pipes, and connect-

Configuration	Random orientation >80% Overlap	Aligned major axis >80% Overlap	Random orientation >80% Overlap	Aligned major axis >80% Overlap
Material and wall thickness	316L Current thickness	316L Current thickness	2304 Half thickness	2304 Half thickness
Pipe to pipe	%	%	%	%
s-s low tolerance M1 (1)	17	47	1	12
s-s high tolerance M2 (2)	100	100	79	82
s-s M1 to M2 (3)	33	39	4	6
Pipe to bend (elbow)	%	%	%	%
s-b low tolerance M1 (4)	22	59	2	16
s-b high tolerance M2 (5)	58	85	6	26

Table 1: Impacts of pipe manufacture on weld integrity in 90 × 316L stainless steel pipes and bends; 80% overlap success rate as a function of manufacturing tolerances and orientation.

ing high and low tolerance pipes.

To accommodate possible future use of stronger duplex stainless steels, the three above sets were repeated by halving the current wall thickness without changing manufacturing tolerances.

As shown in Table 1, it was found that a well-performing weld was difficult to achieve with random orientation of pipes, particularly when the manufacturing tolerances are wider.

Far better results were achieved by aligning major axes. Whilst the welder/pipe fitter is unable to control manufacturing tolerances, he is able to manage orientation and alignment of pipe ends. Pipe tolerances could be adapted using pipe end-forming machines.

Importantly, when considering duplex stainless steel pipes, results show that it may not be possible to use the full strength advantage to reduce wall thickness unless manufacturing tolerances are significantly tightened.

Conclusion

Welding plays an important role in the fabrication and maintenance of processing plants, which are heavily regulated for health and hygiene.

Whilst tanks, distillation columns, condensers and heat exchangers for processing plants are factory built, many pipe inter-connections are made on site. Inadequate welded joints can compromise product quality in an otherwise hygienically designed plant. Poor joints and/or welding can trap bio-film, the source of bacteria and may also lead to microbial induced corrosion (MIC).

Several factors lead to inadequate welded joints. One of these is the alignment of pipes. The pipe fitter/welder can minimise misalignment by rotation and selection of pipes to obtain the best possible fit.

First published in the Australian Welding Journal, Volume 60, 2015.

Tips for designing and assembling a hygienic piping system

Generally the main components are fabricated in factory conditions. Site assembly of components connected by thin-walled narrow pipes is difficult to control.

Finishing a stainless steel surface shouldn't begin after the project is assembled; it should be a consideration in the project's design phase. The initial engineering drawings should be clear about the design and hygiene specifications for the project.

- Right-angled joints such as T-joints and elbows provide a place for bacteria to accumulate and are difficult to clean thoroughly. The project's design should exclude 90° angles.
- Any bend less than 135° should be rounded gently, preferably with a radius of more than 6.0 mm. Some projects, because of their design or the role in the food surface application, can have smaller radii. Regardless of the radius, smooth, gently rounded porosity free welds on the exterior are ideal.
- Because the finishing process typically is the most time- and labour-intensive aspect of the project, it can be beneficial to consider all assembly options. If the forming and fabricating steps comprise more than half the project, it might be more cost-effective to purchase prefinished material, assemble the project, then grind and finish the welds to match the prefinished pieces.
- All joints should have a continuous, butt-type connection and should be finished to No. 4 or finer. If a butt joint isn't possible, press- and shrink-fit joints are viable options.

When two pipes need to be welded together, specify a bevel angle of 30 or 45° to create a V-groove. (*Reference; Wainwright, Simon 2012: Finishing stainless steel for food-grade applications, Fabricators & Manufacturers Association, USA website and March 2012 issue of TPJ-The Tube & Pipe Journal.*)

The standards ASTM A554 (latest edition 2015) and the SABMiller Welding Standards GLT, ENG.ME. ST04 (March 2010), provide welding guidance, although they do not specifically address on-site welding. ASME BPE – 2012 (latest edition 2014) gives extensive information on surface finishes, weld acceptance criteria and welding in general. ASME BPE refers to bio-processing equipment, this requiring a very high degree of attention to detail.

Surface condition I – Polished

Typically, decorative applications, high stress fatigue applications and food processing equipment may require a specified finish, e.g. 0.2 – 0.4 µm Ra.

Surface condition II – Cleaned

This grade is intended to provide the best possible corrosion resistance for a welded joint that is not subsequently mechanically polished, by cleaning off the dark weld oxide and promoting formation of the protective chromium oxide. The welded zone produced by automatic welding processes such as PAW and TIG can be left as-welded where the weld and HAZ have an acceptably low degree of oxidation.

Surface condition III – As-welded

The as-welded condition should only be specified for non-critical surfaces that are not exposed to any corrosive media or food product, and for which appearance is unimportant, e.g. inside handrails, external welds on ductwork, and internal surfaces of structural parts.

Thermal cutting: a new flexibility

African Fusion talks to Sean Moriarty, South African sales director for Koike, about the successful implementation of the company's state-of-the-art Deltatec plasma/oxy-fuel combination cutting system installed together with Koike's machine distributor Retecon at Durban-based cutting and fabrication specialist, Laser Junction.

The worldwide Koike Group was founded in 1918 as a family run business with its head office in Tokyo Japan. Today it has global subsidiaries across Europe, the US, China and Korea. "Koike manufactures high-quality metal cutting, welding and positioning equipment. We have over 90 years of experience and serve steel service centres, heavy equipment manufacturers, general fabrication shops, power generation plants, shipyards, offshore pipe and vessel fabricators, as well educational institutes all over the world," Moriarty tells *African Fusion*. "The company employs around 1 200 people globally and generates revenues of €500-million every year," he adds.

"Koike is an OEM manufacturer for a wide range of CNC cutting machines, covering all common technologies: laser, plasma, oxy-fuel and water jet. We also manufacture gas cutting torches, gas couplings, nozzles in addition an extensive range of portable cutting and welding units for straight, bevel, pipe, H-beam cutting and welding applications," says Moriarty.

Koike have been operating in South Africa for a number of years now through their local distributor Retecon. "Historically, laser cutting was often preferred in South Africa, because of the accuracy and cut quality of laser compared to conventional air plasma or oxy-fuel cutting systems."

"With the developments in technology, high-definition plasma cut quality has improved dramatically over the years, and high-definition plasma cut parts now meet the required standards for the majority of steel construction, engineering and fabrication uses. What is clear in industry today is a large capital investment in a laser machine is not always necessary when a high-definition plasma machine, at a third of the investment cost, is suitable for most jobs.

"However, many factors come into the equation when one is deciding on a cutting system. We at Koike and Retecon will gladly advise plus recommend and offer the right cutting solution for our customer's needs," he adds.

"Each process has its niche in terms of thickness. Oxy-fuel can be used for carbon steels on anything from 3.0 mm all the way to 300 mm plus, while modern mechanised plasma systems are most economical and accurate in the 3.0 mm to 40 mm range. Plasma cutting of plate thicknesses above 40 mm is possible, but at lower quality with increased consumable costs and gas consumption. Lasers have their niche for high-accuracy, high-quality, high-speed cutting in the 0.8 to 16 mm range, while water jet cutting, a non-thermal process, can achieve the highest accuracy and quality on all types of materials and thicknesses including woods and plastics – but it is extremely slow compared to other processes."

The Koike Deltatec 4500 CNC cutting system chosen by Laser Junction. The machine has an effective cutting area of 3×12 m; a Hypertherm HPR260XD auto gas control, high-definition plasma cutting system; and two fully automated Koike K-FIT oxy-fuel cutting torches.

Laser Junction's new cutting system

Laser Junction, established in 1995 in Red Hill, Durban, has established itself as a market leader in the sheet metal industry, specialising in plasma cutting, laser cutting, punch bending and steel fabrication. The company, one of the largest of its kind in South Africa, is currently relocating to a new 10 000 m^2 premises at Dube TradePort, the new Industrial Development Zone at King Shaka International Airport in KwaZulu-Natal.

Laser Junction has been a loyal client of Retecon for over six years, and, to meet the need for a cost-effective cutting solution for thicker section mate-

and precision benchmark

Koike's Katana-ADV CNC controllers incorporate all of the software for controlling the cutting path of the torches, along with the electrical, flame and gas controls for the cutting process being employed.

The Koike system offers high definition cost-effective plasma cutting on plate of up to 40 mm, plus the added flexibility and value of cutting plate of over 150 mm using oxy-fuel.

Laser Junction has established itself as a market leader in the sheet metal industry, specialising in plasma cutting, laser cutting, punch bending and steel fabrication.

rial, decided to complement its fleet of machinery with a combined plasma and oxy-fuel installation.

The Koike Deltatec 4500 CNC cutting system was chosen, a machine with a 4.5 m beam width on a 14 m rail length, giving an effective cutting area of 3×12 m. For cutting, the machine has one Hypertherm HPR260XD auto gas control high-definition plasma cutting system, combined with two fully automated Koike K-FIT oxy-fuel cutting torches, all under the control of Koike's Katana-ADV CNC controller.

"These controllers incorporate all of the software for controlling the cutting path of the torches, along with the electrical, flame and gas controls for the cutting process being employed. When plasma cutting, for example, Hypertherm's True Hole® technology enables high-quality, bolt-ready holes in a 1:1 ratio to plate thicknesses of between 5.0 mm and 25 mm on mild steel material. This is testament to the quality, accuracy and process speed of the Koike machine in combination with Hypertherm's XD plasma systems," Moriarty points out.

He highlights the Portal Frame Compensation (PFC) system feature. The saddles of the Deltatec have a built-in system that enables the gantry to expand with the heat from the cutting processes, while maintaining a constant clearance between the rack and pinion on both sides of the drive system. This ensures a smoother cut surface and less wear on the rack and pinion systems.

At start-up, the machine will automatically measure and calibrate the portal's squareness using two sensors – the actual portal position will be compared with the initial CNC settings when the machine was assembled. The Katana controller will show an on-screen message that warns the operator if the portal is out of spec and readjustment is required.

Other features Moriarty points out are the SmartLift torch carriages together with Smartflow gas distribution, for both plasma and oxy-fuel, incorporated in the Deltatec 4500. The plasma torch, which requires very accurate height control for high definition cutting accuracy, is fitted with a magnetic torch holder for collision protection and maintenance-free ac slide motor with a precision linear guidance system. The oxy-fuel torches with heat protection use electronically controlled proportional valves with capacitive height sensing including an automatic pre-heat and ignition system. In addition:

- A spot laser pointer enables easy manual plate alignment and referencing between cuts.
- An E-cabinet air conditioning system maintains the temperature of the control cabinet at the ideal operating temperature in ambient temperatures ranging from -10 °C to +55 °C.
- A voltage stabiliser compensates for fluctuation of between +10% and -30% from 230 V.
- A network cable connects the Katana controller to a local area network (LAN). "Should any faults develop on the Laser Junction's machine, Koike Europe can log in via Team Viewer, diagnose the fault condition and talk local technicians through a resolution procedure," Moriarty explains.

Also supplied with the turnkey installation at Laser Junction is the SigmaNest nesting software, which was originally developed in South Africa by Mecad Systems. This allows optimisation of material usage and productivity. "While the software is globally supported, because of the local expertise in this area, Laser Junction's SigmaNest system will be directly supported by Mecad in South Africa," Moriarty says.

The cutting table itself is a Herr Plas-Vent exhaust-type table with a modular construction. Exhaust channels run in the longitudinal direction in separate 515 mm transverse sections. "Each of the channels has an exhaust flap, which is automatically opened when cutting in that section. This enables fume extraction in the areas where it is needed, making the extraction process more efficient and reducing the fan power required.

"For Laser Junction, this cutting system significantly extends the company's cutting capability. As well as laser services on plate thicknesses up to 20 mm, the Koike system offers high definition, cost-effective plasma cutting on plate of up to 40 mm, plus the added flexibility and value of cutting plate of over 150 mm using oxy-fuel," Moriarty confirms.

"In addition, the company benefits from local service and support from Retecon and from Koike in Holland, the OEM of the system. Koike are cutting specialists. The solutions they offer are not limited to a single technology and combination system such as Laser Junction's Deltatec plasma/oxy-fuel system, are not only cost effective, they can significantly enhance a company's offering, while optimising productivity," Moriarty concludes.

Steel project specialist centralises and repositions

Renttech, the South African onsite sales and rental specialist for welding and cutting; lifting and rigging; tools and construction equipment has centralised its Gauteng operations into expanded premises in Wadeville. *African Fusion* attends the open day and talks to Renttech SA's Johan Bester, welding product manager; Jannie Bronkhorst, regional sales manager; and Gerrit van Zyl, managing director.

"Renttech's success in the market rests on the highest levels of integrity, performance and customer service. Our vision for the future is to reach a new 'high' in customer support and service. Our brand new, centralised sales facility in Wadeville promises to bring our Gauteng customers greater convenience and the widest available range of equipment in the market," says Van Zyl.

With the largest fleet of welding rental equipment in South Africa, Renttech South Africa services a wide range of industries, from petrochemical to pulp and paper, power generation, manufacturing, mining and engineering. The company's welding portfolio includes the renowned Harris, Lincoln and Uniarc ranges of metalworking products, which are backed by high levels of product expertise.

The company's in-house technical know-how was on display at the launch of the new sales outlet, where customers and guests were able to get a feel for the equipment through live demonstrations and interactions.

"Our sales specialists are known for their expert advice and in-depth knowledge of each item of equipment. This is the result of a long-term commitment to ongoing training and a company-wide focus on customer service," says Bester.

Apart from the Harris range of products used in the brazing, soldering, welding, cutting and gas distribution industries, Renttech provides industries with Uniarc welding machines and plasma cutters, engine-driven welding packs, MIG/MAG torches, TIG torches, CO_2 welding machines and wire feeders, Hypertherm plasma cutters and CNC machines. Renttech SA also distributes Air Liquide industrial gas.

Having been involved in a number of high-profile projects in the petrochemical sector, Renttech provides on-site support and easy accessibility to critical equipment, such as power generation, welding, pneumatic power tools such as the Kuken brand, and personal protective equipment (PPE) during refinery shutdown periods.

"We offer high levels of service during shutdown projects, providing on-site technical support and easy access to industry-critical equipment, such as generators and welding power sources – with the aim of minimising downtime," says Van Zyl.

The company's range of diesel-driven generators range from 5.0 kVA up to 1 000 kVA, and include an extra heavy-duty 'rental spec' series for extreme conditions.

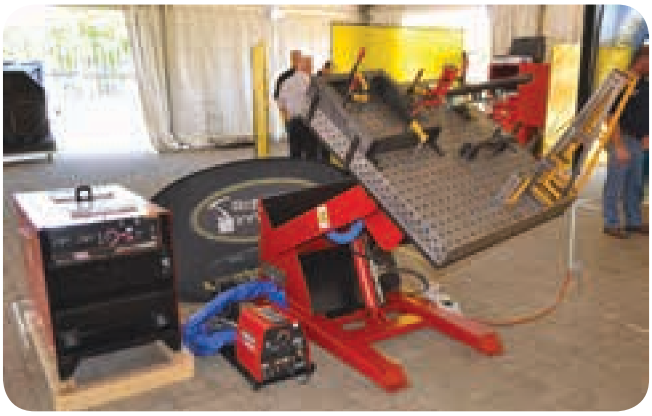
Also specialists in lifting and rigging equipment, Renttech South Africa's Unilift and Kyoto ranges include chain blocks, lever hoists, rope winches, chain slings and rope slings; as well as shackles, endless round slings, pneumatic winches and cargo securing systems. The company's own ISO 9001-accredited manufacturing division, Kelmeg, also produces high quality webbing and endless round polyester slings.

Packaged welding solutions

Increasingly, Renttech is offering packaged welding solutions and support to projects across the southern African region. Citing a project in Beira and Matola, Jannie Bronkhorst says Renttech is currently involved in the construction of bulk storage tanks for diesel, petrol, Jet A1 fuel and LPG storage spheres in Mozambique. "The job is to install a jetty offloading system to take fuel off the

Renttech provides on-site technical support and easy access to industry-critical equipment, such as generators and welding power sources.

Renttech has recently signed a distribution agreement with BUG-O, an ideal product for easy-to-implement mechanisation.



Through systems integrators such as Robotic Innovations, Renttech is able to offer mechanised and automated welding solutions at all levels of sophistication.

ships and to construct the bulk storage and road loading facilities. Ultimately, product coming in will be offloaded into the tanks and then loaded into road tankers for distribution all over Africa," he explains. Renttech is supplying solutions for fabricating the storage tanks, which range from 5 000 m^3 for A1 jet fuel to 20 000 m^3 for some of the bulk diesel and petrol tanks.

"In the past, these would have been joined using stick electrodes (SMAW), and perhaps with some semi-automatic solid-wire or flux-cored gas metal arc welding (GMAW/FCAW) processes. But with productivity and costs under pressure in today's markets, the use of mechanisation and higher productivity processes is essential," Bronkhorst tells *African Fusion*.

The chosen solution involves mechanised electro-gas welding (EGW) for all of the vertical seams and automatic girth welding (AGW) – which uses the submerged arc welding process – for the horizontal floor-to-floor, floor-to-shell and shell-to-shell welds. "The global specialist in these systems is All Time, which is the largest Lincoln distributor in mainland China. Lincoln equipment is used for all the power packs and their submerged arc wire and flux consumables are preferred for the AGW process. All Time manufactures the carriages and the EGW tractors and supplies a special low-slag, CO_2-assisted flux-cored EGW wire for this very high-deposition rate process," he adds.

Four of Renttech's technical support team have received training from All Time on the process. The equipment has now been supplied and training by Renttech staff in Mozambique is about to begin. "This is a big success for us in the southern African market," Bronkhorst says. "What we are trying to do is to move away from operator skill, which is lacking all over the world, and to rely, instead, on solutions that offer better consistency and quality, while significantly improving productivity and lowering costs," he explains.

"Through projects such as these, Renttech is demonstrating that it has changed from being an equipment supplier to being a welding specialist with solutions expertise," notes Van Zyl.

Bester continues: "We have a host of products that are not well known in the southern and South African markets, such as orbital welding systems for tube to tube welding, CNC plasma cutting systems and gasless flux-cored wires, for example. There are many applications where these solutions make economic sense. Following the market, our focus has shifted towards increased productivity. We no longer simply supply machines and commodities. We strive to understand client needs, the scope and priorities of their projects and we explore the full range of options to see which best matches the project budget and the productivity and quality requirements. Then we propose the technology that, on balance, is likely to give the best result," he says, adding, "with the prevailing economic and labour issues we face today, the more modern welding processes often prove to be more cost effective and reliable."

Says Van Zyl: "I think the margins in today contracting arena are so low that there is almost no room for error. Using technology and automation in this context improves predictability and reduces risk. While we have always provided 360° solutions, we now see mechanisation as a growth area."

"We recently signed a distribution agreement with BUG-O, an ideal product for easy-to-implement mechanisation of long welding runs where repeatability is a key factor. Instead of using 4, 5 or 6 welders, one operator or welder can manage a whole job," adds Bester.

The company has developed a containerised welder-training centre for on-site approvals, welder testing and training.

Also new, Renttech has introduced a cold wire pencil feeder from TBi for gas tungsten arc welding (GTAW or TIG). "This is a simple way of improving the productivity of the manual TIG process. TIG welding with rods is a slow process that requires high-level skills. This pencil feeder helps to make TIG welding more accessible and, by eliminating stop starts and irregular manual rod feeding, deposition rates and weld bead quality can be improved," he says, adding that it also enables the process be integrated into robotic welding systems.

"We see many European companies becoming active in South Africa, so our local companies have to compete with them in terms of productivity and quality. They are better exposed to the latest technology and they are not afraid to use it," Bester suggests.

"But our business is not just about welding," notes Van Zyl. "It relates to everything surrounding steel. We have identified a host of areas to bring costs down, while improving productivity and quality. Renttech can offer technology solutions for all aspects of a project: productive solutions that reduce risk and promote successful delivery," he concludes.

Digital radiography:
an NDT growth opportunity

Marco Gonzalez of GammaTec NDT Supplies in Vereeniging summarises the trends being witnessed in the industrial digital X-ray inspection systems market and highlights growth opportunities.

When digital radiography was first introduced for non-destructive testing (NDT) in industrial applications, it was considered to be an ideal alternative to film-based radiography. However, even the staunchest enthusiasts of digital radiography knew that acceptance in such conservative industries such as aerospace, oil and gas, and power generation would be challenging. Now, with the constantly evolving industrial digital radiography market at the cusp of realizing its true potential, it is ironic that aerospace, oil and gas, and the power generation industries are providing the strongest growth opportunities.

The advantages of digital radiography over film-based radiography are well documented and apparent. In summary, these include:

- Lower dosages are needed with smaller safety zones.
- Immediate observation of radiographic images.
- Ability to manipulate, enhance and annotate images.
- Obviates the need for darkrooms and chemical development.
- Efficient data storage.
- Easy to communication electronically.
- Ease of use.
-

Portability is the key to success

With the incremental film-to-digital transition in NDT applications, a trend that is driving and accelerating the adoption of digital radiography is portability. Especially for field applications, portability has provided a different dimension to digital radiography.

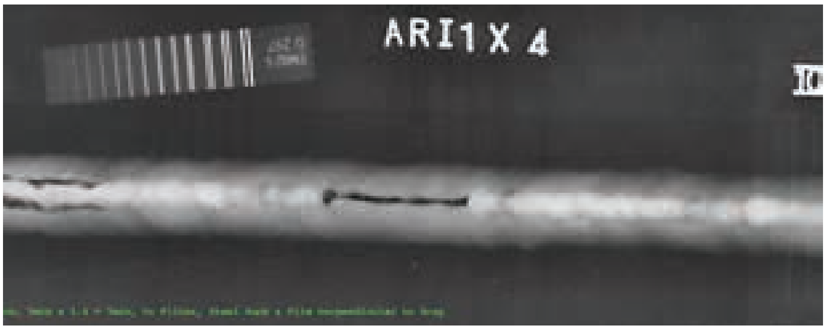
As digital flat panel detectors are not flexible and robust enough, they do not lend themselves to applications such as pipeline weld inspection, where computed radiography (CR) is the preferred digital radiography technology.

Marco Gonzalez of GammaTec NDT Supplies in Vereeniging.

With Carestream NDT's latest product introduction, the HPX-PRO CR system, portability for field applications has taken on a new meaning. As the first step in the transition from film to digital radiography, this portable solution that targets narrow-width applications is expected to be a game changer.

What does the industry need?

For industry, digital radiography needs to retain the fundamentals of radiographic techniques, but it also needs



A digital radiograph of a 12 mm plate weld with and SNR of 111.3 measured in the parent material. This meets the SNR minimum requirements of 98 (1.4 times 70) if not measured in weld the weld metal.

to enable satisfactory and repeatable results to be obtained economically. What this means is that users of the technology need clear, unambiguous guidelines of what and how to measure and monitor basic image quality parameters during technique development and for subsequent production images.

The various ISO 19232-5 and ASTM standards meet this need by providing objective measures and guidance relative to some key image quality considerations. First is basic spatial resolution (SRb) of a digital image, which is a measure of effective pixel size and an indicator of the capability of an imaging system to resolve detail

"With Carestream NDT's latest product introduction, the HPX-PRO CR system, portability for field applications has taken on a new meaning," says Gonzales.

in an object under examination.

Second, signal-to-noise ratio (SNR) can be measured in a given region of interest in a digital image to represent how well a system is able to display or discern object features against random background noise. And finally, clear guidance is given on when and what image quality indicators (IQIs) are to be used to verify the quality and acceptability of an image.

These image quality measures and well-defined procedures make digital radiography a standardised methodology – and move it beyond the 'art' and guesswork it once was.

Market overview

Frost & Sullivan research finds that the global industrial digital X-ray inspection systems market generated between US$350-million and $400-million in 2014. Within this, the computed tomography (CT) segment accounted for the maximum revenue, followed by DR and then CR. All these three market segments are experiencing incremental change in product development and end-user adoption.

An increase in end-user productivity is the key driver across all product segments in the industrial digital radiography market. With operational costs increasing and a lack of qualified NDT technicians, especially in digital radiography, products that can simplify the workflow and offer easy-to-use instruments without compromising the quality of inspection will experience the greatest success.

Conclusion

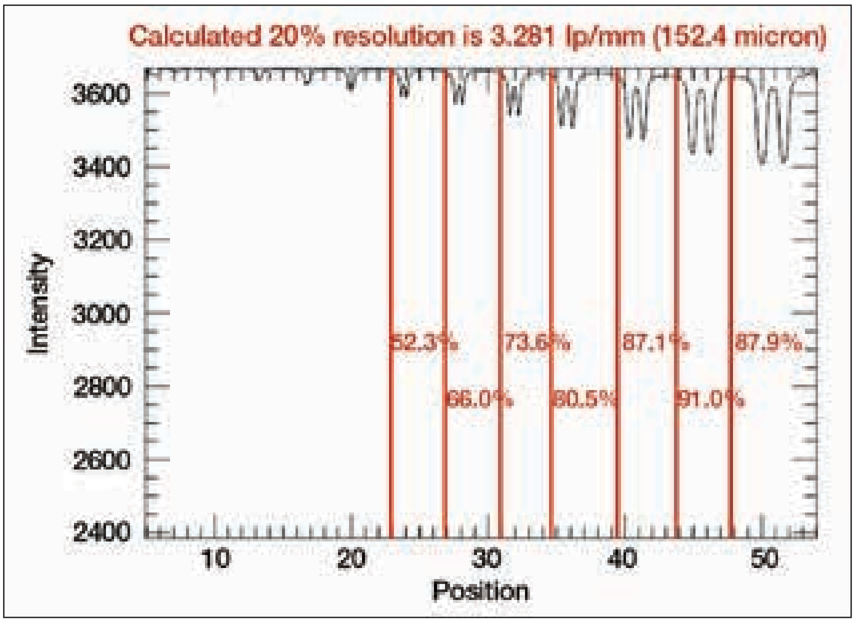
Over the past five years, the industrial digital radiography market has experienced significant development and change, which is driving greater adoption of this technology over film-based radiography. While the advantages are apparent, the evolution of standards, training, and products has taken longer than expected, inhibiting its adoption.

Now, the technology has matured, with products being competitively priced and offering productivity gains. In addition, the process is a greener alternative to film-based radiography. Conservative industries such as aerospace, oil and gas, and power generation, which initially resisted the transition from film to digital radiography, are now more accommodating and are, in fact, driving the adoption of this technology.

Although, film radiography continues to be the preferred choice in emerging economies where the operational costs are lower than in developed economies, it is expected that, over the next three to five years, the evolution of digital technology will render film-based radiography unattractive.

Mega trends, such as the Industrial Internet of Things, Big Data, and Industry 4.0, demand the adoption of smart digital solutions that will progressively phase out radiography on film.

Growth opportunities in the industrial digital radiography market are now available to South Africa's NDT service providers. Carestream, together with GammaTec NDT Supplies, are fully committed and prepared to assist in training the industry in this technique in order to make the transition from conventional films to digital radiography easier.



A resolution calculation of 152.4 µm meets the requirement of being below 160 µm.

Reference

1 Nikhil Jain , Frost And Sullivan report.
2 BS EN ISO 17636-2:2013, Non-destructive testing of welds — Radiographic testing.
3 Steven A. Mango , Qualification of a Computed Radiography System's Exposure Range for Optimum Image Quality.

Optimised PTA hardfacing process

Thermaspray, South Africa's market leader in surface engineering and thermal spray coating technology, has optimised the parameters of its plasma transferred arc (PTA) coating process to ensure high quality, crack-free Stellite™ hardfacing deposits on a wide range of substrates.

Shaik Hoosain in Thermaspray's in-house European-approved metallurgical laboratory, the only dedicated facility of its kind in Africa's thermal spray industry.

Weld deposits of hardfacing alloys are commonly employed to increase the service life of components that are subject to abrasive wear and corrosion. Properties in the deposits vary and, generally, greater life is achieved with deposits of higher hardness, typically with hard carbides in the matrix.

Hard carbides, however, have a tendency to cause cracking in the deposit on cooling. Because this cracking does not significantly reduce the service life of the component, it is sometimes seen as advantageous in reducing residual stresses in the surface deposit.

But, as Shaik Hoosain, metallurgical engineer at Thermaspray points out: "In many instances, cracking, whether to obtain a sealing surface or to prevent fatigue failure, is undesirable. Cracking in Stellite hardfacing alloys is, essentially, related to the very high strength and low tensile ductility of the weld deposit – and its sensitivity to dilution," he explains. "To avoid cracking in these hardfacing deposits, it is essential to control or adjust parameters. We have, therefore, developed welding procedures for our PTA process that are strictly controlled to ensure high hardness Stellite deposits that are free from cracks and flaws," he assures.

Outlining the PTA process, Hoosain explains that this hardfacing procedure heats metal powders, which are blended by means of the constriction associated with the plasma arc. "It is a versatile method of depositing high quality, metallurgically fused deposits on relatively low cost substrates," he informs *African Fusion*.

The PTA process was first introduced to the welding industry in 1964 as a method of bringing better control to the arc welding processes in the lower current ranges – and is complimentary to both thermal spray and conventional fusion welding. "PTA is mainly used on components that are subjected to severe corrosion or abrasion; thermal shock; slurry erosion; or extreme impact forces. The process gives the necessary protection to the substrate by providing a coating that can withstand these conditions," Hoosain says, adding, "PTA can be applied in practically every case where hardfacing solutions are needed."

Cracking in the subsequent deposits result from unequal cooling rates within the deposit and the expansion mismatch between the substrate and the weld. Thermaspray has addressed this through the dilution of the Stellite by a steel substrate, which results in a reduction of compositional mismatch, making a more ductile weld deposit by decreasing the carbide content. Furthermore, as more low-dilution, high-hardness layers are deposited, the sensitivity to cracking can be further reduced through correct preheating procedures and current level/heat input control.

"The cracking risk is also influenced by preheat levels and ensuing cooling rates. Here, it is most critical to carefully control the heat input, which makes it possible to control weld dilution to less than 5%, which is crucial for many high-performance alloys," says Hoosain.

There are a number of important advantages of the PTA process compared to conventional arc welding processes. These include:

- Precise control of important welding parameters and a high degree of consistency.
- Controlled heat input, at lower levels than those associated with conventional arc welding processes, ensures weld dilution can be controlled to between 5.0 and 7.0%.
- Weld deposits are characterised by low levels of inclusions, oxides and discontinuities.
- The weld hardfacing layer closely mimics the corrosion resistance of the equivalent alloy.

Thermaspray, ISO 9001 accredited and an Eskom level 1 approved supplier of coatings and PTA solutions, has conducted several welding qualification procedures on various material substrates.

In a joint venture with Surcotec, Thermaspray offers an extensive portfolio of engineering and thermal spray coating solutions that extend component life, which assist OEMs and end-user clients across southern Africa to reduce costs and increase production.

Based in Gauteng and the Western Cape respectively, Thermaspray and Surcotec's world-class quality, wear- and corrosion-resistant thermal spray coatings, PTA cladding and polymer coatings – in partnership with Plasma Coatings USA and Diamant Metalplastic Germany – are augmented by a host of specialised allied services. These include coating finishing technologies such as machining, grinding, diamond grinding, probe track burnishing, electrical run out measurements and reporting, linishing, and super finishing.

www.thermaspray.co.za

A PTA-applied hardfacing coating on a high temperature steam valve components.

SA-made electrical connections for maximum uptime

Powermite is a component, equipment and system specialist that leads the southern African market in high quality, locally manufactured electrical products for an extensive array of mining and industrial applications, including welding.

"Quality and reliability are prerequisites for extending the lifecycle of products operating in the notoriously harsh mining environment," says Powermite director, Donovan Marks. "Our range of electrical products, manufactured locally by Proof Engineering and Ampco, are all ISO 9001: 2008 compliant. Both companies also carry SABS approval to IEC 60079 Part 1 and 2 and SANS 1489 – 2005, and to 60309 Part 1 and 2. "Local manufacture ensures rapid product and spares availability, another vital element for maximising productivity," Marks adds.

Proof produces PLM366 and 415/515 plugs and sockets as well as an 11 kV, 800 A tunnel couplers and adaptors for open cast applications. "We also have a 22 kV 400 A coupler for draglines and we recently extended our product offering even further with the launch of a new 35 kV, 400 A coupler and adaptor for overhead line skids," says Marks. An extensive series of plugs, sockets, couplers and adaptors, ranging from 120 A, 1.1 kV to 400 A, 12 kV, is also available from Proof for underground equipment.

Unique to the offering from Proof Engineering is phase-to-phase segregation, eliminating the risk of phase-to-phase-faults, which, in addition to costly downtime, can cause serious injury to personnel. Another of the company's innovations is the unique ProAlloy coupler that is manufactured from non-theft material – a combination of zinc, copper and aluminium that makes the coupler 33% lighter than its brass counterpart with no significant resale value. The subsequent reduction in theft risk lowers the potential for unplanned downtime and subsequent production losses.

Ampco manufactures plugs and sockets for underground operations as well as a range for industrial applications. Available from 16 A to 63 A at 200 to 230 V; from 16 A to 125 A at 380 V to 400 V; and from 16 A to 125 A in the 500 to 525 V range, these products are ideally suited for mobile generators, pumps, welding machines, factory installations, and more.

The Ampco range features a unique interlocking design that prevents the end user from removing the plug under load, while the application of LM 6 reduces the possibility of corrosion and extends the product lifecycle.

The Mennekes industrial range of plugs and sockets from AMPCO are ideally suited for mobile generators, pumps, welding machines, factory installations, and more.

Proof Engineering and Ampco are part of Powermite and all three operations are members of the Hudaco Group.

www.powermite.co.za

Wear survey and mapping services minimise downtime

Industrial operations can improve efficiencies related to total cost of ownership of wear protection systems by making use of Rio-Carb's cost and obligation-free wear survey and wear mapping service offering.

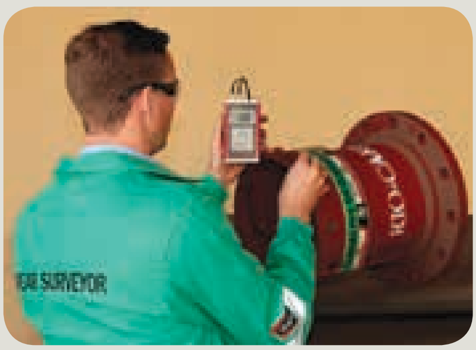
The service was officially launched in August 2015, and is a proactive solution to the costly and time-consuming effects that unforeseen wear can have on liners and pipes carrying abrasive materials. Rio-Carb product development manager, Luis Garcia, reveals that the company is able to produce a wear map, which reveals the greatest wear areas on materials handling equipment, by using advanced ultrasonic equipment that is operated by staff that are qualified in chute draughting.

"This can result in huge savings for customers, as areas of less wear may not require replacement. The thickness measurements are carried out to the nearest 0.1 mm, and the areas are zoned by permanent marking, thereby ensuring that subsequent replacement checks can be reliably predicted. We are also able to estimate when and where our Chromium Carbide (CrC) liners should be installed by identifying the sharp-end of the wear system," he explains.

Garcia says that this service is also of great importance when planning shutdowns for maintenance. "A costly industry trend is to wait for a hole to appear in the chute before replacing the entire liner. This only leads to increased downtime and more liner material being used. A monthly calculation of wear loss on each wear plate enables us to calculate the most suitable times for replacement."

The wear survey and wear mapping service is available to operations in the mining and allied resources industries. Garcia notes that it has been trialled at a South African coal mining operation since July 2015, with positive results. "The encouraging feedback prompted us to go live with this offering, which also enables us to improve our turnaround times and efficiency based on strategic calculations undertaken on site," he concludes.

www.riocarb.co.za



Rio-Carb, the South African manufacturer of chromium carbide liner plates, is now offering a wear survey and mapping service for materials handling equipment.


Where there is wear,
'wear'
the right partner

Technology centre promotes next-step welding

In line with the company's global drive, Lincoln Electric is in the process of setting up a new welding technology centre (WTC) in Midrand, Gauteng. "We have always had workshop space in this facility, but we are now installing a permanent demonstration centre to allow us to promote our full range of welding solutions," says Benoit Lamotte, regional manger for sub-Saharan Africa and the Indian Ocean.

"We have the machines, the consumables and the welding knowledge to enable us to bring the best of the world's productivity solutions to local customers. We are striving to move people up the technology ladder, from wherever they are. All the next-step welding solutions in this centre target productivity: increased deposition rates; higher duty cycles; and reduced grinding and cleaning times after welding, for example," Lamotte tells *African Fusion*.

"In South Africa, for example, we are promoting Tandem submerged arc welding with ac/dc machines as a step up from traditional single wire dc submerged arc systems. Tandem sub-arc welding with Lincoln PowerWave ac/dc power sources offers significantly higher productivity and process control, which can result in much lower total costs of production," he explains.

Another key focus for Africa is pipeline welding. On display is Lincoln Electric's STT solution for root welding and its mechanised flux-cored welding systems, which use Lincoln's BUG-O solution. "For pipe welding work, we want to move people away from using solid GMAW wire to using flux-cored and metal-cored wires, which offer higher deposition rates. And to replace stick welding (SMAW) we are showcasing the advantages of using Innershield gasless flux-cored wires as a substitute," Lamotte says, adding that these wires are ideal for site-based work in Africa, where shielding gas is not always readily available.

Aluminium welding also features: "We aim to move people away from using 1.0 mm wire to using 1.2 or 1.6 mm wires, even on thin plate. This can be achieved using pulse, pulse-on-pulse and other advanced waveforms available from PowerWave power sources.

Introducing Lincoln's 'True Energy' platform for the more accurate monitoring of heat input on highly responsive, modern inverter-based welding machines, Lamotte says that the welding of modern materials, such as duplex and super-duplex stainless steels, requires careful attention to weld-metal metallurgy. "Many of today's applications require very tight control of heat input, for example. Through True Energy and Production Monitor, we are able to embed high levels of monitoring and control into the PowerWave product range to simplify the task of achieving good quality welds in complex materials," he assures.

Keeping abreast of the Internet of Things, PowerWave machines can be allocated an IP address and directly connected to the Internet, allowing them to be remotely monitored and/or controlled. Productivity and welding parameters can be monitored in real time or downloaded on a daily weekly, or monthly basis.

"It's all about productivity," he reiterates. "We welcome customers at all levels of sophistication to visit us at this new centre, where we will strive to develop better welding solutions for any application," he concludes.

Lincoln Electric's WTC in Midrand is promoting next-step welding technologies such as Tandem submerged-arc welding with Lincoln PowerWave ac/dc power sources.

www.lincolnelectric.com

Dual Vantage: the power of two

On construction sites, along pipelines or in any other rugged environment, welding must be done on time and with minimal rework. The mathematical solution is simple: two operators on the same engine drive can work twice as fast as one.

The Dual Vantage® 700 – driven by a 69 hp (51.5 kW) Cummins® Turbo Diesel – delivers plenty of power for two welding arcs with enough left over to run lights, grinders, plasma cutters and other tools – including gouging thick materials with up half-inch carbon rods – while still enjoying a smooth and controllable arc.

With the double stator design, the ac generator power circuit is completely separate from the weld circuits.

Designed to be easy to use and easy on the budget, the Dual Vantage 700 saves money, not only at the time of purchase, but every time it is started, because lower capital investment costs and the maintenance costs accrue by buying and servicing one engine rather than two.

Whether welding with SMAW, GMAW or FCAW, construction welders rarely use more than 300 A. The Dual Vantage 700 delivers that and more to each operator, while providing outstanding puddle control, even for difficult joints and positions.

Standard stainless steel roof and side panels and engine-access doors deliver added protection, durability and corrosion resistance. Dual Vantage effectively doubles the potential of a single machine.

www.lincolnelectric.com

The Dual Vantage® 700 – driven by a single 69 hp (51.5 kW) Cummins® Turbo Diesel engine – delivers power to two welding arcs with enough left over to simultaneously run lights, grinders, plasma cutters and other tools.

Efficient Engineering's diversified strategy

At an open day held on 29 September, Efficient Engineering's managing director, Graham Hartley, says that, withstanding plunging commodity prices and resulting slowing demand, the company continues to be part of the solution within the South African steel industry, which plays a critical role in mineral beneficiation and is a key enabler of every part of the economy. The top five steel consuming industries include the automotive, mining; construction, energy, and infrastructure sectors, which jointly contribute 15% of total South African GDP and employ more than 8-million people.

Through developing its own intellectual property in the areas of custom engineering mining solutions, pressure vessels and modular solutions, Efficient Engineering continues to diversify its business. The company has gone from purely mechanical design and manufacture, to including electrical design, and full integration, installation and testing of modular power control, electro-houses and generator sets. Efficient Power, an Efficient Group that was launched only 18 months ago, has since turned over more than R100-million.

"We offer first to market, tailor made solutions to our clients through the expertise of our management team, which has more than 200 years' cumulative experience in harnessing contemporary machinery and industry leading manufacturing processes.

"This has led to our robust growth and has seen us evolve from a respected family business to becoming the preferred supplier for numerous blue chip original equipment manufacturers in the local and international mining and material handling; oil and gas; satellite communication and radio astronomy; petrochemical; as well as engineering industries. Further, we continue to add to our diverse portfolio through acquisitions such as that of Trotech, a division recently purchased through the business rescue process."

Trotech, now known as Efficient Trotech, offers specialist services in the field of engineering, design, manufacture and installation of bulk storage tanks, pressure vessels, heat exchangers, reactors, air receivers and fired heaters to the petrochemical, mining and minerals industry, as well as to the pulp and paper sectors. It is an exciting addition to Efficient Engineering, which currently boasts total manufacturing space of 21 600 m^2, making if fully equipped to undertake any engineering job, regardless of its size or complexity.

At Efficient Engineering, equipment is fabricated to world-class standards by a hand-picked team of production staff, many of whom are highly skilled artisans and metalworkers. This is essential to maintaining the requirements that allow the company to retain its ISO 9001:2008 certification, year after year. The company is also ISO 3834 certified as well as OHSAS 1801:2007 compliant.

A benchmark audit conducted by the United Nations Industrial Development Organisation's (UNIDO) Subcontracting Partnership Exchange (SPX) programme resulted in an outstanding outcome. Under the category of Overall Performance and Practices Matrix, Efficient Engineering was placed in the 'world class' quadrant, along with only a few other international group companies operating in the same league.

Also, the prestigious SAISC Steel Awards recognised Efficient Engineering, its partners and client as overall winners this year for their work on the SKA Africa Radio Antenna Positioner project. The judges said that this project 'radiates excellence not only in the use of structural steel but in every aspect of its structure and purpose.'

"This is testament to our commitment to being a partner of choice to our clients as well as good corporate citizens – by contributing towards the growth of the economy through world class solutions that benchmark South Africa against global industry standards," concludes Hartley.

Graham Hartley, MD of Efficient Engineering (centre) with Warwick Jackson of Efficient Power (left) and Vees Moodley of Efficient Trotech (right) photographed at the open day event.

Efficient Engineering's current flagship project is for the Meerkat antennas for the Square Kilometre Array project (SKA). The company is completing the fabrication and full electrical and mechanical integration of the yokes and pedestals for the first 64 Meerkat antennas.

A fabrication of a dragline bucket on display at Efficient Engineering's open day.

Compact TPS/i series welding systems

Fronius has introduced a new portable TPS/i power source range for use on construction sites and for mobile workshop applications.

The new compact Fronius TPS/i series C Pulse power sources are ideally suited to portable use in workshops and for onsite plant work.

Fronius has expanded its tried and tested TPS/i series to include the TPS 270i C Pulse and TPS 320i C Pulse power sources with an integrated wire feeder. The new entrants, designed for welding currents of up to 270 A and 320 A respectively, combine the advanced features of the TPS/i platform in an extremely compact housing, and are equally suited to MIG/MAG, dc-TIG and MMA welding. These power sources can be used anywhere, and with their space-saving construction, are the ideal solution for mobile applications in workshops and on construction sites.

Despite their compact design, the TPS 270i C Pulse and TPS 320i C Pulse leave nothing to be desired in terms of performance and flexibility. In addition to the pulse-welding package included in the scope of delivery, the proven standard welding package from Fronius is available as an option, as well as packages for LSC (low spatter control) and PMC (pulse multi control) processes developed for the TPS/i series. Numerous pre-prepared characteristics and useful functions simplify the welding process, such as SynchroPulse for achieving a wave pattern in the weld seam similar to that of TIG welding. Carefully considered details, including colour-coded wire feeder rollers corresponding to the wire diameter, a viewing window to quickly check how much wire remains and an easy-to-understand user interface, also make it easier to use the welding system.

The Fronius water-cooled TPS 270i C Pulse, has an integrated wire feeder for a compact design.

Furthermore, numerous equipment options and a wide range of accessories, such as gas- or water-cooling, a remote control or a handy PullMig welding torch enable the machines to be adapted quickly and easily to the specific circumstances and to a range of applications. As the fully digitised power sources can access the Internet, it is very easy to upgrade and update the software on site.

The new devices are available for all standard mains voltages and mains frequencies, meaning they can be used worldwide.

The TPS 270i C Pulse and TPS 320i C Pulse enable welders to achieve outstanding results with high repeatability and boast maximum productivity in any given location, even under extreme conditions.

Fronius products are distributed in South Africa through Bolt and Engineering Distributors (BED).

www.bolteng.co.za

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