Necsa Nuclear: SA's nuclear accredited fabrication facility

Our SAIW Member profile for this month comes from the South African Nuclear Energy Corporation (Necsa) Nuclear Manufacturing, which is the only nuclear-accredited facility in sub-Saharan Africa. *African Fusion* visits its workshops in Pelindaba and meets the company's ASME III-, ASME VIII-, ISO 9001- and ISO 3834-accredited fabrication team.

Originally established in 1962, Nuclear Manufacturing is based on the Pelindaba campus of Necsa and, having successfully maintained its ASME III and N-stamp status since first being accredited in 2011, holds South Africa's only nuclear manufacturing capability. It had already been certified to ASME VIII in 1996.

The manufacturing facilities include 85 000 m^2 of manufacturing area with a handling capacity of up to 100 t and a rolling and bending thickness capability of up to 35 mm. Nuclear Manufacturing has expertise in welding all grades of stainless steels, aluminium, titanium, duplex steels, carbon steels and other high alloys.

With demand for nuclear components being limited to replacement parts for Koeberg and Necsa's own NTP nuclear test facility, however, the facility has become a specialist jobbing shop for high-specification pressure vessels, heat exchangers, tanks and piping systems, mostly for the power, petrochemical, and chemical processing industries.

"We are a high-integrity jobbing shop that manufactures a significant number of components for Koeberg, for example, to ASME III and ASME VIII," says Frans Lubbe, the company's project manager and estimator at Necsa.

To supplement nuclear work, Necsa's Nuclear Manufacturing also has an ASME VIII U-stamp accreditation to enable it to tender for high-tech fabrication for projects from all over the world. "As Necsa Nuclear Manufacturing we have worked with countries such as Russia providing processing vessels for the food and beverage market. These were food-grade stainless steel tanks that had to be internally polished to mirror finishes to remove the risk of microbiological contamination from product being entrapped in rough areas of the tanks," Lubbe tells *African Fusion*.

"We also manufactured vessels for Rheinmetall Denel Munitions in Potchefstroom that had to be even more highly polished," adds project coordinator, Niël van Heerden. "The vessels were part of a mixing plant for explosives and if any substances get trapped in rough areas, an explosive reaction could be initiated," he explains.

Other non-nuclear work undertaken by Necsa Nuclear Manufacturing includes:

- Process vessels for the wax plant in Sasolburg.
- Medupi and Kusile Power stations boosters and intermediate strainers for the boiler feedwater circuits.
- Piping and nozzle welding for the Sulzer pumps on the Medupi and Kusile boiler feedwater pumps, for which phased-array UT was used to confirm the defect-free quality.
- Refuelling water storage tanks for the boiler feedwater.
- Liquid- and turbine-drain flash tanks (LDFTs and TDFTs) for the air-cooled condenser circuits (ACCs) of Medupi power station.
- Coolers and strainers for the large (4.4 by 14.2 m) ACC structures for the Medupi and Kusile coal-fired power stations.

Nuclear manufacturing's unique offering, however, is the fabrication of components fit for deployment inside the nuclear islands of power plants. "We are currently busy with the essential water cooling systems services project, known to us as the SEC Piping project, which is for Koeberg Nuclear Power Station," says Vossie Vorster, Nuclear Manufacturing's production manager.

The design, fabrication and quality management team of Necsa Nuclear Manufacturing, from left: Emmanuel Netshishivhe, Project Coordinator; Karabo Maluleka, QC Inspector; Vossie Vorster, Production Manager/Welding Technician; Johan le Roux, NDE Officer Level 1&2; Niël van Heerden, Project Coordinator; Frans Lubbe, Project Specialist; Suzan Makhado, QA Officer; Kobus Booyse, Project Coordinator; Nic Badenhorst, Engineering Draughtsman; Ian Pretorius, QC Inspector; Willard Maraire, Program Manager.

Necsa Nuclear Manufacturing's team of highly skilled and qualified welders are all coded to meet ASME III and/or ASME VIII Code requirements: From left: Daniel Dlamini, Francois Strauss, Alfred Ramagoshi, Paulos Molefe, Steve Molefe and Coert Steynberg (Welding Supervisor).

"This involves the fabrication of replacement cooling water piping for the two nuclear reactors at Koeberg, so it is a critical part of the plant," continues the company's design draughtsman, Nic Badenhorst. "They used to be made from carbon steel with rubber linings to provide corrosion and abrasion protection. The filtered seawater still contains some micro particles, however, that have caused the rubber to erode and lift, exposing the carbon steel to seawater corrosion," he explains.

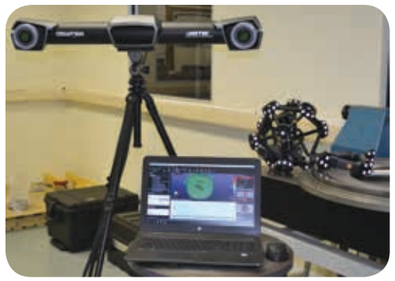
The replacement piping being manufactured by Necsa Nuclear Manufacturing is made from a modified super duplex stainless steel material called AL-6XN/UNS N08367. "This is a complex super-duplex with raised chromium, molybdenum and nickel alloying elements that impart better high temperature, corrosion and abrasion properties to the piping," continues Vorster.

Following careful design of each individual pipe section and the development of welding procedure specifications (WPSs) and qualification records (PQRs), welding jigs were manufactured for each pipe section. "We have become specialists in duplex welding, which requires very tight control of the heat input. On this piping project, we have to achieve tight dimensional tolerances, so we manufacture the pipe sections in very precise jigs, which we have also manufactured ourselves. We have to carefully control the distortion associated with each weld pass. So, as the welding progresses, we change the welding sequence to minimise shrinkage and distortion and to ensure that when the section is removed from the jig, the end flanges are within tolerance," Vorster explains.

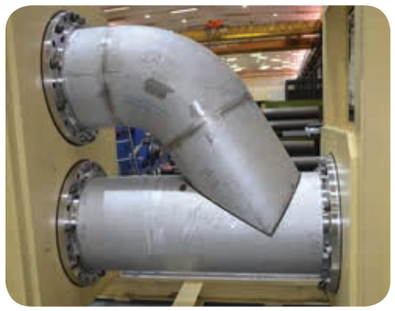
"Once we have a set of pipe sections, the whole assembly is mocked up on the shop floor to guarantee seamless installation onsite. Gaskets are used between each flange and, once the bolts are tightened, the gap tolerance has to be between 3.1 and 3.3 mm for fitting the pipes. This would be impossible to achieve without overcoming the distortion issues," he adds.

Each section of SEC piping is independently pressure tested and, from an NDE perspective, 100% of the butt weld joints have to pass radiographic testing (RT), while all fillet welds and brackets are subjected to dye-penetrant testing (PT). "We have our own X-ray booth and we use equipment from Gammatec for

An assembly of SEC piping mocked up on Necsa Nuclear Manufacturing's shop floor to guarantee seamless installation onsite.



Accurate to within 30 µm, Necsa Nuclear Manufacturing's mobile laser-based scanning system can inspect a 4.0×4.0 m assembly from a single position while determining dimensional accuracy between multiple points selected using touch probes.



Following careful design of the SEC piping, welding jigs were manufactured for each individual section.

An intermediate strainer vessel manufactured by Necsa Nuclear Manufacturing according to the ASME VIII code for the ACCs of the Medupi power station.

radiography. We also have a new pump at our pressure testing facility, which sometimes has to be used to take selected components beyond their bursting point," Vorster notes.

To enhance dimensional inspection, Necsa's Program Manager, Willard Maraire, says Nuclear Manufacturing has also recently acquired a 3D scanner for inspecting and certifying the accuracy of the SEC piping sections. Accurate to within 30 µm, this mobile laser-based scanning system can inspect a 4.0×4.0 m assembly, determining dimensional accuracy between multiple points selected using touch probes. It uses a Metra Scan 3D 750 Elite in conjunction with Handy Probe Next equipment and enables Nuclear Manufacturing to quickly perform conformity assessments of fabrications or components against the 3D CAD models or OEM specifications.

Citing another nuclear success, Willard says that in January 2018 Nuclear Manufacturing supplied the first locally manufactured ASME III (N-Stamp) vessel fabricated in full compliance to ASME Section III, Subsection NC for the Koeberg Nuclear Power Plant (KNPP). This vessel was the first locally produced safety related ASME III designed and certified Air Receiver Pressure Vessel for Koeberg. The vessel was specified to be a Safety Class 2 nuclear vessel via a comprehensive RPE-certified (registered professional engineer) design specification. "The vessel's role is to maintain pressure for the 20 m containment building equipment hatch seals under all operating conditions, including seismic events," he tells *African Fusion*.

With respect to welding choices, Voster notes that high integrity vessels invariably have a gas tungsten arc (GTA) root weld. "We then fill the joints with gas metal arc (GMA) or submerged arc welding (SAW) if we can manipulate the joint into the flat position for access," he says.

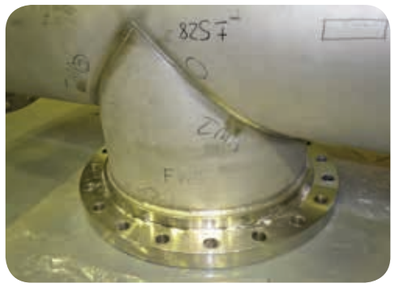
"We have a team of very highly skilled and qualified welders that are all coded to meet the ASME III and/or ASME VIII Code requirements, depending on the job," he says adding that all of the Necsa Nuclear Manufacturing workshop's welders can be deployed on any of the processes used.

"Typically, every new job requires the welders to do a requalification test piece for the work they have been allocated. These 'coupons' are sent for mechanical testing and they must pass for the welder to be considered for the work. We then proceed to do a Procedure Qualification Record (PQR) using the allocated welding procedure, and these test plates are also thoroughly tested so that, by the time the welder starts assembling the actual component, we all have total confidence in the welding procedure and the welder's ability," Voster explains.

Nuclear Manufacturing has recently been recertified by SAIW according to the comprehensive quality requirements (Part 2) of ISO 3834, Quality requirements for fusion welding of metallic materials – for the fourth time. "Although ASME III and ASME VIII are more specific and more onerous in terms of quality requirements, we also maintain our ISO 3834 Part 2 accreditation with the SAIW. This gives us international recognition and opens the door for us to tender for overseas work. Also, though, there are aspects of ISO 3834 that are not included in the construction codes, such as the maintenance, calibration and verification of the welding machines, for example, which we believe is very important," says Vorster.

"If welding equipment is neglected, it can make it more difficult for the welder to achieve the weld quality required. It can even call into question whether the specified procedure has been accurately applied. By strictly adhering to ISO 3834 requirements, these pitfalls can be completely avoided," he adds.

"We have to operate to the highest welding quality levels in everything we do and ISO 3834 gives very clear guidelines about the things one has to avoid and the things one must do to achieve the required end quality. It is impossible to know for sure that a weld is sound just by looking at it, so the step-by-step observance of a pre-certified procedure, implemented accurately by pre-qualified welders is the only way to consistently achieve success," Vorster concludes.



These high integrity pipe seams have a gas tungsten arc (GTAW) root weld, hot pass, filler and cap.

In January 2018, Nuclear Manufacturing supplied the first locally produced safety related ASME III designed and certified Air Receiver Pressure Vessel to Koeberg.

To avoid explosive reactions, vessels manufactured for Rheinmetall Denel Munitions in Potchefstroom had to be highly polished to avoid any substances get trapped in rough areas.