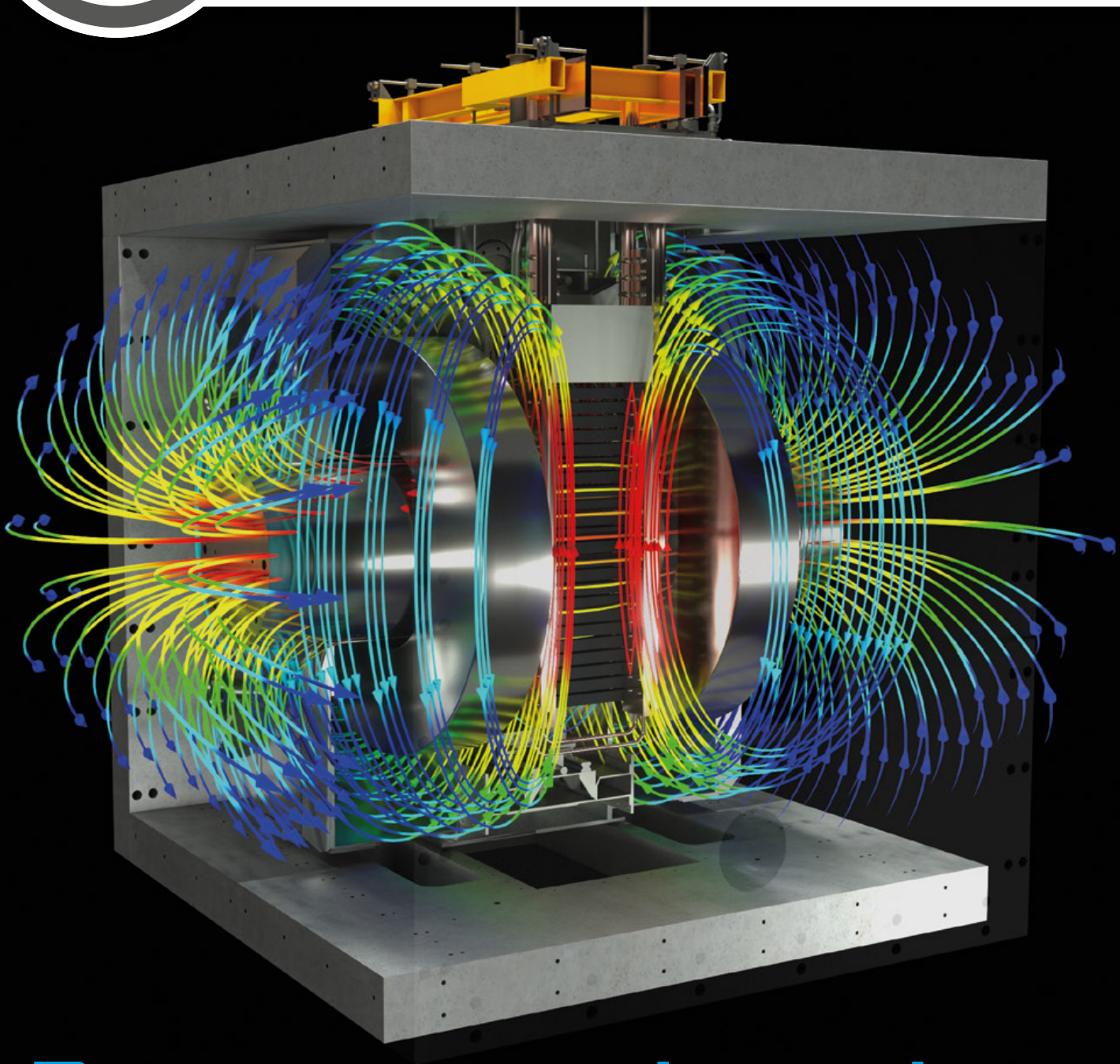
NUCLEAR AMRC news

No.41 Autumn 2021

- Green machining
- Pressure vessel fabrication
- Construction technologies
- Fit For Nuclear
- Skills



Extreme engineering

Inside UKAEA's new facility for fusion materials and manufacturing

CATAPULT
High Value Manufacturing

New capability directory

The latest edition of the Nuclear AMRC's capability directory offers a deep dive into the centre's expertise and resources.

It includes detailed introductions to the centre's advanced production-scale machining platforms, welding cells, inspection facilities, and other state-of-the-art manufacturing equipment.

For the first time, the directory also includes case studies to show how the team are helping businesses and driving innovation through a range of commercial and collaborative projects, plus an introduction to the centre's supply chain development services.

To download a copy:
namrc.co.uk/download/nuclear-amrc-capabilities

Nuclear AMRC News 41 contents

Jacobs joins to drive supply chain innovation

Material world: inside Jacobs' High Temperature Facility at Birchwood Park.

Jacobs has joined the Nuclear AMRC to drive innovation in advanced nuclear technologies.

As a tier one member, Jacobs will collaborate on manufacturing and material engineering projects for new build, decommissioning, equipment qualification and digital technology development.

With its head office in Texas and operations in more than 50 countries, Jacobs provides a full spectrum of professional services including consulting, technical, scientific and project delivery for the government and private sector.

"We aim to add value to the Nuclear AMRC's work with UK manufacturers, helping them to win work in the nuclear supply chain and meet nuclear industry requirements through innovation and business improvement. This work will also strengthen Jacobs' UK supply chain and supports the UK's long-term nuclear vision," said Greg Willetts, Jacobs vice president for technology and cyber solutions.

"Among many synergies, the Nuclear AMRC's knowledge of the latest manufacturing technologies will increase Jacobs' capability to develop novel manufacturing systems and product solutions for its clients, while the breadth of our involvement in the nuclear market will benefit the Nuclear AMRC."

Jacobs and the Nuclear AMRC were both part of the UK SMR consortium led by Rolls-Royce to carry out initial development of its new power plant design, and both also work with other new reactor developers. Jacobs is leading research into materials, manufacturing and component testing systems for a variety of new reactors, and is currently constructing the unique Chimera test rig for UKAEA's new Fusion Technology Facility in South Yorkshire (see p14).

Before they can be deployed in nuclear plant, any new materials and manufacturing techniques must go through a qualification process to guard against any risk of failure during decades of service in extremely challenging environments.

To support the equipment qualification process, Jacobs will use its advanced materials testing facilities, including the UK High Temperature Facility in Warrington, to analyse the behaviour of material samples from the Nuclear AMRC under conditions similar to those experienced within reactor systems.

"New nuclear power plants will play a crucial part in reaching the UK's net zero carbon emissions target, and we will work with Jacobs to help ensure that new reactor designs can be produced efficiently and cost-effectively by the UK supply chain," said Andrew Storer, CEO of the Nuclear AMRC.

"Future designs of small and advanced modular reactors, including fusion reactors, will require a range of novel materials and manufacturing techniques. Our new relationship with Jacobs will help us build code cases for these new techniques to demonstrate to the regulators that they are safe to use."

www.jacobs.com

Making better busbars for electric vehicles

Quality focus: busbar production at HV Wooding.

The Nuclear AMRC is working with Kent-based manufacturer HV Wooding to develop a new powder coating process for crucial components for electric vehicles.

HV Wooding, which specialises in providing precision engineered metal components for the automotive and aerospace sectors, is working with materials and engineering researchers from the Nuclear AMRC and other parts of the University of Sheffield to improve the quality of its busbar products.

Supported by Innovate UK through the Faraday Battery Challenge, the project focuses on investigating and developing alternative coating methods to improve the performance and integrity of the busbars, which carry high-current power between parts of an electrical system.

"Current coating methods are difficult to control, with a high level of components rejected because of poor quality insulation," explains Paul Allen, sales director at HV Wooding. "There is currently no standard specification or process availability, and our new method will contribute supply chain capability and capacity for battery and energy storage applications.

"We will develop a best practice testing method to standardise quality assurance where there is currently no international standard, and this could generate up to £1 million in additional sales to our business."

As well as collaborating with the Nuclear AMRC on advanced manufacturing methods, HV Wooding will work with university-based researchers to develop a standardised test procedure for quality assurance, demonstrating that each busbar meets all the required integrity standards with minimal risk of failure in use.

"The current busbar coating process is difficult to control and can't currently be scaled up to meet customer demands in the UK," says Dr Li Li, head of the Nuclear AMRC's control & instrumentation research group. "This project will help ramp up production at HV Wooding while also minimising the product failure rate.

"Our team will bring our expertise in electro-mechanical design, process, testing and manufacturing to ensure this collaboration will ultimately enhance the UK's capability in producing quality busbars for automotive and adjacent supply chains."

HV Wooding previously worked with the Nuclear AMRC through the Fit For Nuclear programme, which helps manufacturers meet the quality expectations of the nuclear supply chain.

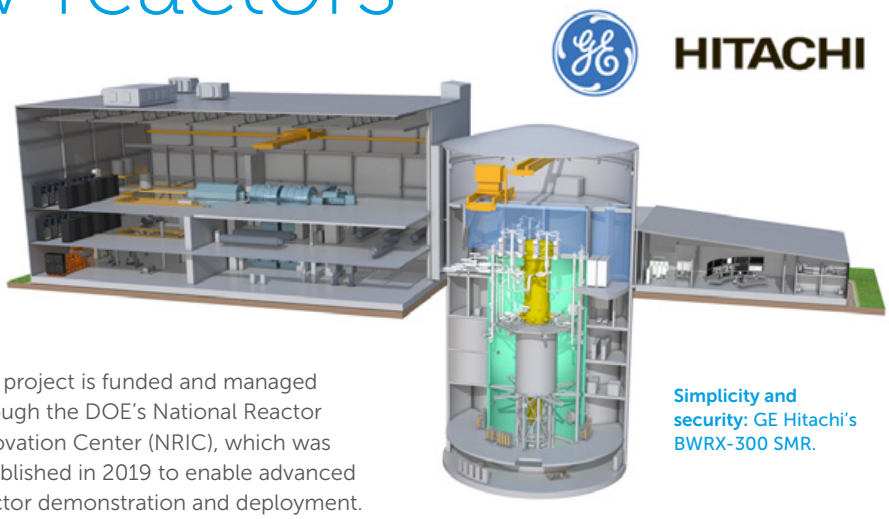
The one-year project will also draw on the specialist capabilities of the University of Sheffield's AMRC and the Department of Electronic and Electrical Engineering.

"Powder coated insulated busbars are safer than heat shrink sleeved alternatives," Allen notes. "They have better thermal and electrical performance alongside other benefits in compact battery design – for example saving up to 10 per cent clearance and creepage distance. If the innovative and optimised epoxy powder coating process is implemented, it will definitely open up new markets and will lead to new skilled jobs in our area."

www.hvwooding.co.uk

International collaboration aims to lower construction costs of new reactors

The Nuclear AMRC is part of a new US-led collaboration to develop advanced construction technologies that can together reduce the cost of new nuclear builds by more than 10 per cent.



Simplicity and security: GE Hitachi's BWRX-300 SMR.

The project, referred to as the Advanced Construction Technology initiative, is led by GE Hitachi Nuclear Energy and backed by the US Department of Energy (DOE) with $5.8 million funding.

Researchers will demonstrate three technologies (see box), leveraging promising developments from other industries which have not been tested within a nuclear energy context. These technologies can be applied to a variety of advanced reactor designs to significantly improve the economics of bringing advanced reactors to market.

The Nuclear AMRC is bringing its expertise in sensor development and welding, including weld simulation, to the project. The research will involve close collaboration with the US-based Electric Power Research Institute (EPRI), a tier one member of the centre.

"We are delighted to support GE Hitachi and our member EPRI on this exciting project," says Dr Li Li, head of the Nuclear AMRC's control & instrumentation group. "The assurance of construction integrity is a vital consideration for advanced nuclear reactors, and we are seeing more reactor designs using below-ground construction to provide additional protection from natural or man-made hazards.

"By applying sensor-based structural health monitoring and real-time condition monitoring techniques, we will help bring the digital replica alive to optimise the cost of construction, operation and maintenance, and to improve the safety of advanced reactors over decades of low-carbon power generation."

The project is funded and managed through the DOE's National Reactor Innovation Center (NRIC), which was established in 2019 to enable advanced reactor demonstration and deployment.

"Construction costs and schedule overruns have plagued new nuclear builds for decades," said Dr Kathryn Huff, acting assistant secretary for nuclear energy at DOE. "By leveraging advanced construction technologies, we can drive down costs and speed the pace of advanced nuclear deployment – much-needed steps to tackle global climate change and meet the President's goal of net-zero carbon emissions by 2050."

GE Hitachi Nuclear Energy is currently developing the BWRX-300 small modular reactor (SMR), for potential deployment by 2028. Based on proven boiling water reactor technology, the BWRX-300 is designed for simplicity, with a variety of passive safety systems for the secure provision of clean, flexible baseload electricity.

"We are excited to work with DOE, NRIC and the outstanding team we have assembled to help evaluate how innovative construction methods and technologies can reduce the cost of advanced reactor construction," said Jon Ball, executive vice president of GE Hitachi Nuclear Energy. "We know this funding will significantly benefit the commercialisation of SMRs and pave the way for other advanced reactors."

The Advanced Construction Technology consortium also includes UK companies Caunton Engineering and Modular Walling Systems, US engineering group Black & Veatch, utility group Tennessee Valley Authority, Purdue University, and the University of North Carolina at Charlotte.

The project will be conducted in two phases. The first will focus on technology development and preparation for a small-scale demonstration. Pending its successful completion and future appropriated funds, a second phase is planned to carry out the demonstration within three years.

nric.inl.gov/advanced-construction-technologies-initiative

The Advanced Construction Technology initiative focuses on three areas:

- **Vertical shaft construction,** a best practice from the tunnelling industry which could reduce construction schedules by more than a year.
- **Steel Bricks,** modular steel-concrete composite structures which could significantly reduce the labour required on site.
- **Advanced monitoring and digital twins,** which can create a detailed virtual replica of the nuclear power plant structure.

Research highlights

Recent publications by Nuclear AMRC researchers.

Understanding machining-induced distortion in nuclear alloys

www.nafems.org/congress

Part distortion is a common problem in machining across all sectors, but research into predicting and controlling it has mostly focused on aerospace alloys. By comparison, the distortion behaviour of many alloys used in the civil nuclear sector is not so well understood.

The Nuclear AMRC's Arman Zonuzi and Tauseef Syed led research to better understand the post-machining behaviour of 316L stainless steel. The researchers used finite element modelling (FEM) to simulate and predict distortions induced during milling, then carried out machining trials to compare the results with the simulations.

To understand the factors that affect distortion, the team monitored cutting parameters including feed and spindle speed, and the clamping force of the fixture. Testpieces were scanned before and after milling.

In results presented at the NAFEMS World Congress in October 2021, the team showed that the initial residual stress in the steel workpiece has a much larger impact on distortion than the cutting and process parameters. Understanding the process history of the workpiece is therefore vital.

The project also showed that the FEM methodology can predict part distortion, helping manufacturers minimise or eliminate defects during the machining of large high-value components for nuclear applications.

The team now aim to investigate other materials, workpiece geometries and toolpaths, and replicate the process on actual nuclear components.

Uncertainty evaluation for on-machine measurement

www.euspen.eu/knowledge-base/ICE21308.pdf

High-value manufacturing increasingly depends on real-time measurements made during production processes. Most new machine tools come equipped with on-machine probing systems, allowing machining and metrology to take place on the same platform. By reducing the need to move the workpiece between machine tool and CMM room, this can significantly reduce production time and cost for large components.

However, in-process measurement on a machine tool is not yet fully traceable. Because both machining and measuring processes are performed on the same machine, both can suffer from identical geometric errors. This uncertainty in measurement means that the results are not reliable enough to provide sufficient confidence to meet customer or regulatory requirements.

To better understand the sources of uncertainty in shopfloor applications, the Nuclear AMRC's Feng Li, Tauseef Syed and Joseph Hiley set out to evaluate the uncertainty on machine tool measurements in different environments.

The team used the Nuclear AMRC's largest machining platform, the Soraluce FX12000, to mill a standardised testpiece measuring around 600mm square with a range of features. The finished piece was measured five times immediately after machining with a Renishaw on-machine tactile probe, and again under no-load conditions. The testpiece was then taken to a high-precision CMM machine for benchmark measurement.

The results showed that systematic errors, of up to 0.05mm across the testpiece, were the main source of uncertainty. Repeatability was very good, showing that measurement procedure uncertainty was low thanks to an effective compensation algorithm, and calibration uncertainty for the CMM measurements was just 0.001mm. Temperature variation could be a significant source of further error, the researchers noted.

Initial results were presented at Euspen's 21st International Conference in June. Future work will focus on developing a fast and reliable calibration of the machine tool's geometric errors, which will help to keep systematic errors under control.

Ultrasonic research for **environmentally-friendly machining**

A new research collaboration is developing a lubrication system for environmentally-friendly machining, using an innovative ultrasonic technology to precisely deliver a tiny quantity of oil to the cutting zone.

Clean machine: Stuart Vere of Kugel Rotary.

Manufacturers will be able to retrofit the new system to their current machining platforms, allowing smaller businesses to reduce costs and environmental impact without having to invest in new machines.

The £1.35 million UltraMQL project is led by Derbyshire-based machining specialist Kugel Rotary Services, and funded by Innovate UK through its Smart Grant programme.

Research partners include the Nuclear AMRC, international machining fluid provider Quaker Houghton, Derby-based digital visualisation and immersive technology specialist Bloc Digital, and the University of Brighton's Advanced Engineering Centre.

"Lubrication is a critical factor for successful chip formation during metal cutting processes," says Stuart Vere, managing director of Kugel Rotary Services. "Insufficient lubricant as well as excessive lubricant can have a detrimental effect on quality, cost and time and have an adverse impact on the environment. Just like other flexible variables such as speeds and feeds, the application of lubrication should also be optimised to ensure the best results whilst keeping overall oil contamination to a minimum.

"The introduction of UltraMQL will significantly reduce overall oil volumes and at the same time allow that all-important additional element of control, hence alleviating the challenges faced when using and maintaining alternative lubrication methods."

The three-year project builds on established minimum quantity lubricant (MQL) techniques which, instead of flooding the cutting area with coolant, deliver a tiny amount of oil to the cutting zone – typically less than a millilitre a minute.

Recent research by the Nuclear AMRC has shown that MQL can reduce running costs by up to half and energy use by a fifth. It can also avoid the need to clean the component after machining, and reduce health risks to machine operators.

Effectively delivering such a tiny amount of lubricant isn't simple. Current systems typically use a simple mechanical device known as a Venturi tube to turn the liquid oil into an aerosol. Their performance can suffer from any changes in oil viscosity or temperature, resulting in poor surface finish or contamination of the machined component.

The UltraMQL collaboration focuses on using ultrasonic vibration to create the aerosol, reducing the size of oil droplets by an order of magnitude. This will avoid the effects of oil viscosity, allowing the systems to be used with a much wider range of oils, with a rapid changeover between machining tasks.

The University of Brighton will develop a new high-precision ultrasonic lubricator, and apply laser and imaging measurement techniques to verify the spray performance against flow rate and droplet size requirements. "A finer oil mist with precisely controlled droplet sizes and flow rate will deliver a much more reliable machining lubrication system," says Professor Cyril Crua of the Advanced Engineering Centre. "This will be achieved using ultrasonic technology, normally found in research grade atomisers, which can be precisely tuned to produce highly repeatable oil droplets."

The proposed technology will create an electrostatic charge in the droplets, which will stop them coalescing and help them adhere to the workpiece.

The system will also use smart sensors including acoustic and visual monitoring, allowing the machine operator to remotely monitor key process parameters in real time, and enabling a digital twin of the machining platform.

"The creation of these next-generation virtual representations of the factory is driving advantages in increased productivity, improved quality and reduced risk within the manufacturing processes and production management," notes Dr Frank McQuade, director of capability at Bloc Digital. "The remote monitoring, real-time interventions and forecasting benefits of digital twin technologies enable managers and engineers to apply best practices to improve and manage assets in real time without physical modelling or costly production stoppages."

Following development and testing of the various parts of the project, all the innovative technologies will be integrated into a prototype system for trials at Kugel Rotary's factory.

"We need to bring together expertise in multiple fields to achieve a successful integration," says Dr Agostino Maurotto, technical lead at the Nuclear AMRC. "The UltraMQL consortium is formed of technology leaders who have overlapping knowledge and experience in each others' fields. The synergy of competences will be instrumental in the successful development of a working prototype."

Hours not days: electron beam welding can slash process time.

Welding time slashed for **SMR pressure vessels**

An international collaboration has demonstrated how electron beam welding can help slash the production time and cost of reactor pressure vessels for a new generation of small modular reactor.

Over the past three years, the Nuclear AMRC has worked with EPRI (Electric Power Research Institute) in collaboration with the US Department of Energy to develop new manufacturing and fabrication methods which could accelerate production and reduce costs for pressure vessels and other large nuclear components.

The ongoing project, which received second-phase funding in June, aims to demonstrate that small modular reactor (SMR) pressure vessels can be manufactured in less than 12 months, from the current production schedule of around three years.

One potentially game-changing technology identified by EPRI is electron beam welding, which allows multiple arc welded passes to be replaced by a single deep-penetration weld.

"Electron beam welding provides the opportunity to cut costs by 40 per cent compared to conventional technologies," says Marc Albert, senior technical leader for EPRI's advanced nuclear technology programme. "Collaborative projects like this one are addressing the most urgent challenges facing nuclear power and better positioning the industry to meet society's changing energy demands."

The thick-section welding required to join wrought vessel sections is often a bottleneck in pressure vessel fabrication. Conventional arc welding techniques, such as submerged arc welding, are labour-intensive and time-consuming, involving multiple weld passes with periodic inspections. Reducing this time while meeting the required quality standards would help cut the overall production time and costs.

Electron beam welding provides a number of distinct advantages over conventional techniques, says Dr Will Kyffin, Nuclear AMRC head of welding and materials.

"It's about 10 times faster than traditional arc welding, providing considerable cost savings," Kyffin explains. "The heat affected zone is minimal, due to the reduced heat input. And since filler metals aren't required, specific heat treatments can be employed to optimise the alloy's grain structure, restoring the fracture toughness comparable to that of the base material."

Removing filler metals also eliminates any problems with filler metal embrittlement.

"Effectively removing the presence of the weld potentially eliminates the need for costly in-service inspections, and reduces outage times and worker exposures," Kyffin notes.

To demonstrate the feasibility of electron beam welding for pressure vessels, the Nuclear AMRC team carried out extensive tests and trials in the centre's giant Pro-Beam K2000 chamber. Believed to be the largest electron beam chamber available for collaborative R&D anywhere in the world, the K2000 boasts a range of advanced features for joining and additive manufacturing.

Initial work focused on process development to ensure the required weld properties could be achieved. The welding parameters were then used to join sections of a two-thirds scale pressure vessel, based on the upper and lower assemblies of a design from US reactor developer NuScale Power.

The project successfully demonstrated that electron beam welding can be applied to thick section circumferential welds. The team joined two shells, with outside diameter of 1800mm and wall thickness of 80mm, in just one hour – using conventional techniques, this would take around 40 hours in process time alone.

The potential time savings will be even greater for larger components or thicker walls, Kyffin notes.

One challenge in thick-section circumferential welds is that microstructural defects can arise when the electron beam power is reduced at the end of the process. The team developed a novel slope-out procedure to minimise this risk, and validated the results using both destructive and non-destructive testing methods.

All non-destructive testing on the weld has now been validated against the ASME code requirements, a vital step in getting the process approved for nuclear fabrication.

As well as pressure vessel production, thick-section electron beam welding could be used to produce other components including pressurisers, steam generator shells, headers, valves and turbine discs.

As part of the EPRI collaboration, the Nuclear AMRC also contributed to research into automated cladding and near-net shape manufacturing of pressure vessel components (see box).

The project was funded by the US Department of Energy (DOE), with industrial partners from both sides of the Atlantic including Sheffield Forgemasters, a founding member of the Nuclear AMRC. In June, the DOE awarded an additional $3.4 million funding to support the collaboration for another two years.

"The Nuclear AMRC continues to provide tremendous innovation for this game-changing technology, leading the development and demonstration of electron beam welding for nuclear applications," says Albert.

Collaborating with UK manufacturers on the project means that the domestic supply chain will be in a strong position to win work internationally as SMRs move into commercial production, Kyffin notes.

The team shared results with manufacturers at a webinar in July, with more than 150 delegates attending.

For a full technical report on the project, go to: **www.epri.com/research/products/000000003002021037**

Watch EPRI's project video: **youtube.com/watch?v=a_YM2YjnAoA**

Diode laser cladding is a powerful technique for automated deposition of thin layer of protective alloy to the vessel interior. It can use significantly less material than conventional techniques, with no need for machining after cladding.

The Nuclear AMRC demonstrated that diode laser cladding can be readily applied to complex geometries, including features of the pressure vessel's lower dome and head, in shorter times and at lower cost than conventional techniques.

Applying a 2.2–2.5mm layer of 308L stainless steel cladding to a dome of 1.8m diameter with a variety of complex features took 21 hours.

Hot isostatic pressing of metal powder can be used to form large and complex components at near-net shape. It's ideal for complex components with multiple nozzles and connections, such as the reactor vessel head, which are challenging to produce as forgings.

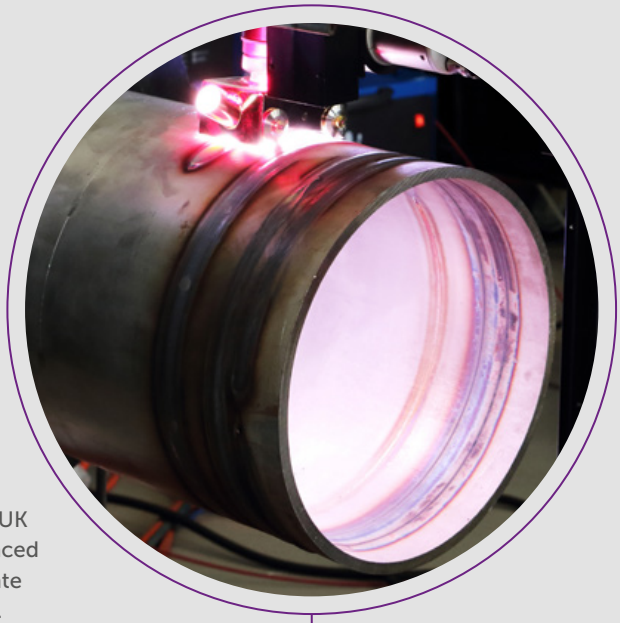
The Nuclear AMRC carried out an extensive analysis of commercially available metal powders, comparing the mechanical performance of test billets formed by hipping. The analysis showed that components made from austenitic stainless steel powder can meet the material requirements of the civil nuclear industry.

To prove the viability of the process for pressure vessels, partners produced a variety of two-thirds scale components including lower head sections which then underwent machining and welding trials at the Nuclear AMRC.

Protective cladding: a vessel dome in the diode laser cell.

K-TIG joins waste container welding project

Welding technology specialist K-TIG will work with the Nuclear AMRC to develop innovative automated fabrication techniques for decommissioning waste containers.



Through the keyhole: K-TIG's welding technology in action at the Nuclear AMRC.

The Nuclear AMRC is developing a new technology demonstration facility at its Rotherham research factory which will integrate a range of state-of-the-art fabrication, monitoring and inspection techniques for waste container production.

The heart of the facility will be a robotic welding cell with the fabrication capability for the 3m³ stainless steel boxes used to safely store decommissioning waste.

These containers are critical for the decommissioning of the UK's nuclear power sites. Automated robotic fabrication using K-TIG's welding technology is seen as key to meeting the exacting quality standards required.

The Nuclear AMRC's technology demonstration centre will de-risk the fabrication process, and help UK manufacturers to modernise their fabrication capabilities and participate in the ongoing decommissioning programme.

K-TIG's keyhole welding technology has now been selected as the preferred option for demonstrating welding techniques for the Tranche 2 containers scheduled to be procured from 2024/25. Under a memorandum of understanding signed in September, K-TIG will work with the Nuclear AMRC to design, develop and supply the robotic welding cell that will fabricate these mission-critical containers.

Ben Hall, K-TIG's general manager for the UK and Europe, said the initiative will underpin the upskilling of the UK fabrication industry and advanced welding applications, and create sustainable jobs for the future.

"Our research and development partnership with the Nuclear AMRC embodies Industry 4.0 and the UK factory of the future," he said. "Working with the world-leading nuclear research body Nuclear AMRC, the robotic welding cell will showcase the precision, quality and efficiency of advanced K-TIG welding solutions which incorporate cutting-edge keyhole technology, robotics and real-time quality assessment. It will fast become the standard for nuclear waste storage container welding."

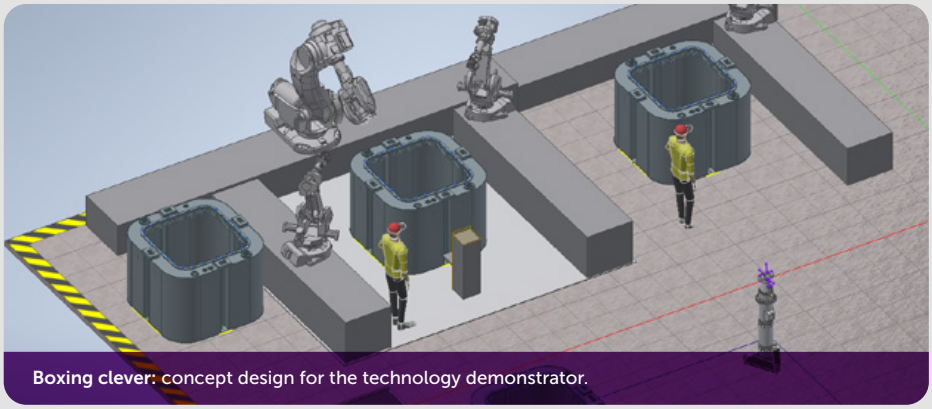
K-TIG became a member of the Nuclear AMRC in December 2019 to collaborate on high-performance fabrication techniques for waste containers and other nuclear applications. The Australian company's patented keyhole welding technology can produce welds 10–100 times quicker than conventional tungsten gas arc welding, joining metals up to 16mm thick in a single pass.

"The Nuclear AMRC and K-TIG will work together to further develop highly advanced methods to manufacture a range of products, including containers for the safe and secure storage of radioactive waste from the nuclear sector," said Sean Murphy, strategic relationship manager at the Nuclear AMRC. "A successful conclusion to the collaboration would be to provide UK manufacturers with a turnkey solution for the fabrication of the products. This will help to ensure a strong supply chain, maintaining safe, repeatable quality and delivery."

K-TIG will provide key equipment for the welding cell including the integrated welding automation, container manipulator, robotic welding arm and K-TIG welding systems, as well as the automated pre and post-weld inspection systems for real-time quality checking. K-TIG will also work with industry partners to integrate commercially available welding manipulators and robots, as well as ultrasonic, visual and acoustic sensor systems, to provide a turnkey welding cell for the fabrication of Tranche 2 containers.

K-TIG will fund the development of the welding cell for the Nuclear AMRC's demonstration facility. K-TIG will maintain all commercialisation rights to the robotic welding cell, and make it available to the global nuclear waste containment fabrication industry.

www.k-tig.com



Boxing clever: concept design for the technology demonstrator.

Robotic rethink for **weld inspection**

A new robot-based approach to inspecting safety-critical welds for nuclear fabrications could be safer, less obstructive, and offer higher performance than established techniques.

Since summer 2020, the Nuclear AMRC has worked with Cumbrian technology development company Createc to develop and test a robotic system for safely inspecting welds with minimal disruption to production.

Funded by BEIS through the advanced manufacturing and materials competition of the Nuclear Innovation Programme, the Mobile Weld Computed Tomography (MW-CT) project aimed to improve the safety and performance of weld radiography. This is an essential inspection technique for many welds in safety-critical assemblies in a variety of industries, and will be vital for the development and production of new designs of small and advanced reactor.

However, the health safeguards required for the intense x-rays used in radiography mean that inspection can be a bottleneck in production.

"The current techniques for radiographic inspection are limited in the sense they are very proscriptive – either you have to take your workpiece to a specific place, or get all the people out of the workshop to carry out the radiography," Etienne Hocquard, head of robotics at Createc, told delegates at a webinar to share the results of the project.

"We thought we could do this differently – how can we use robots to use CT scanning directly on the workpiece, without disrupting the production line?"

Createc's approach uses a pair of collaborative robots positioned either side of the welded workpiece. One carries an x-ray source; the other carries a CCD image sensor to capture x-ray transmission and an off-the-shelf 3D scanner.

The CCD sensor is very cost-effective compared with a standard CT scanner, Hocquard noted, with a 20-micron resolution which is good enough for any significant weld flaw.

Collaborative work: the prototype MW-CT system, with twinned robots carrying an x-ray source and sensor array.

From the control point of view, the main challenges were in synchronising the movement of the two robots, and avoiding collisions with the workpiece and surroundings. "Collaboration of the system is absolutely essential, as is alignment of the workpiece with the parameters of the robots," Hocquard said. "You need to be very accurately positioned."

Initial tests on thin metal samples have proven the feasibility of the approach, with the next stage of research aiming to produce data from thicker weld samples produced by the Nuclear AMRC.

The centre's welding team designed a series of test coupons for the project, featuring intentionally flawed welds of 10–15mm depth in stainless and carbon steels.

To benchmark the performance of the Createc system, all the coupons have been analysed using a CT chamber and a selection of ultrasonic NDT techniques. John Crossley, head of non-destructive testing for the Nuclear AMRC, then compared the results from all the different technologies across all standard flaw dimensions, finding only very minor variations between techniques. These coupons are available for any other technology developers who want to test innovative weld inspection techniques, he noted.

Trialling the MW-CT system on these thicker welds will require a more powerful x-ray source than the 130kV source used in the initial tests, but the team are now preparing proposals for ongoing development.

"We have learned a great deal, and know exactly what the next step will be," Hocquard said. "That's why we do innovation."

The project also involved Workington-based TSP Engineering, a member of the Nuclear AMRC, as industrial partner and host for the trials.

Hocquard and Crossley presented the MW-CT results at a webinar in September, hosted by the RAIN Hub for robotics and AI for the nuclear industry.

createc.co.uk

Steel city winners: the SFR team at Silverstone.

Welding support helps Sheffield racers to victory

A University of Sheffield team supported by the Nuclear AMRC won top honours at the Formula Student competition at Silverstone.

Sheffield Formula Racing (SFR) has represented the University of Sheffield in the international Formula Student competition since 2010. Each year, a team of students designs and builds a single-seat race car, which is then put through its paces at the Formula Student UK competition run by the Institution of Mechanical Engineers.

For the past four years, the team have worked with the Nuclear AMRC's arc welding engineers to fabricate the chassis from steel tube using a high-precision TIG pulse welding technique.

This year, the SFR team were crowned overall winners in a series of events at Silverstone Race Circuit in July – only the second time a UK team has taken the top place.

Pushing the limits: the SFR car hits the track.

The team took the lion's share of the trophies, picking up awards for endurance, sprint, design and the most efficient internal combustion vehicle.

"The skilled welders at Nuclear AMRC allow us to have confidence in our design, meaning we can push limits and design a no-compromise lightweight chassis," said Thomas Nalson, a second-year Mechanical Engineering student and leader of the chassis and driver environment team for SFR.

"Being able to assist on site with the build allows the team to understand the manufacturing process and help design better jigs. The partnership between the Nuclear AMRC and Sheffield Formula Racing goes a long way to provide members of the team with invaluable experience and skills that certainly contributed to the win at Formula Student UK."

www.sheffieldformularacing.co.uk

Executive **view**

Seizing the opportunities of the **energy transition**

This autumn's energy crisis, coming just weeks before the UN conference on climate change, does seem to have focused some minds on the need to tackle long-standing challenges. When I visited the major party conferences to take part in panel discussions on new nuclear development and the hydrogen economy, I found a renewed appreciation of the need for nuclear as part of the clean electricity mix.

The rocketing costs of gas have shown that we need to improve the security and affordability of our energy. In the UK, we're also now aiming for total decarbonisation of the power supply by 2035. We need to manage that transition in a way that creates opportunities for UK companies and workers today and for generations to come, and provides wealth across the country.

Investment in new nuclear power can help solve all these challenges, if we move quickly enough to seize the opportunity.

There are ambitious plans being developed for the Sizewell C, Wylfa and Rolls-Royce SMR programmes which can all contribute to our clean energy goals in the early 2030s. If they all go ahead alongside Hinkley Point C, they could make up a total capital investment of some £100 billion in the next decade. Beyond that, there's the potential of advanced reactors and fusion.

Around half of that investment will be going into the manufacturing supply chain. That means a lot of potential work for the UK supply chain – possibly more than we can manage with today's capacity.

At Hinkley Point, EDF expects to spend about 64 per cent of construction costs in the UK. For its domestically-designed SMR, Rolls-Royce is aiming for 80 per cent of value to be manufactured in the UK. Across the board, let's say that about 70 per cent of total investment could go to the UK supply chain, given our current capabilities and capacity.

Any way that we can increase that share will add significant value to the UK economy, with billions going to UK companies, creating long-term jobs, and being spent in our industrial towns and cities.

It's surely worth investing a few tens of millions in the supply chain to capture that opportunity while securing clean energy for decades to come. We need to provide targeted supply chain support to grow the capability and capacity of the UK's manufacturers. That was acknowledged in the Nuclear Sector Deal three years ago, but little has really happened yet – although, with the deal now being refreshed, I remain hopeful we will see some movement and investment in the supply chain.

Our Fit For Nuclear programme shows what can be achieved with targeted supply chain support. F4N-granted companies have so far reported that the business improvements they've introduced with support from F4N have helped them win over £1.4 billion worth of new contracts in nuclear and other sectors.

But F4N doesn't go far or deep enough to do everything that needs to be done. It was designed as a first touch for manufacturers looking to enter the nuclear sector or benchmark their capabilities – it's not about filling gaps in the market, or providing the depth of support that companies need to reach their full potential. That requires more support.

If the UK supply chain can't meet the requirements of nuclear developers, we will all lose out. For gigawatt-scale power plant, the UK will be buying from overseas developers. The easiest route for them is to rely on their own established suppliers who they can trust to work to familiar codes and standards. It's simple business sense for them to see a less experienced UK supply chain as presenting a greater risk of delay and overspend.

We need to help our manufacturers build on the experience of Hinkley Point C, grow their capability for Sizewell C, and keep building for other sites and new technologies.

We have the opportunity to put the UK at the front of a growing global market. Every nation in the world faces similar energy challenges of growing demand and the urgent need to decarbonise. We have the opportunity as an industry to take the lead in reducing the cost and maximising the economic benefits of the low-carbon transition, and using nuclear to open up deeper decarbonisation opportunities including more efficient hydrogen generation and synthetic fuel production.

With most of our current nuclear capacity set to retire by 2030, now is the time for significant action to replace the current fleet and grow it to meet our future needs, while creating fantastic careers, business opportunities and export potential. We just need Whitehall to make clear and bold decisions.

Inside the new centre tackling the manufacturing challenges of fusion power

UKAEA's new Fusion Technology Facility opened its doors in September to showcase its world-leading capabilities for testing components for fusion power plant.

Based close to the Nuclear AMRC on South Yorkshire's Advanced Manufacturing Park, the new facility will lead the development of technologies and materials for fusion power stations – including UKAEA's STEP, which aims to deliver the world's first prototype of a commercially viable fusion plant (see p16).

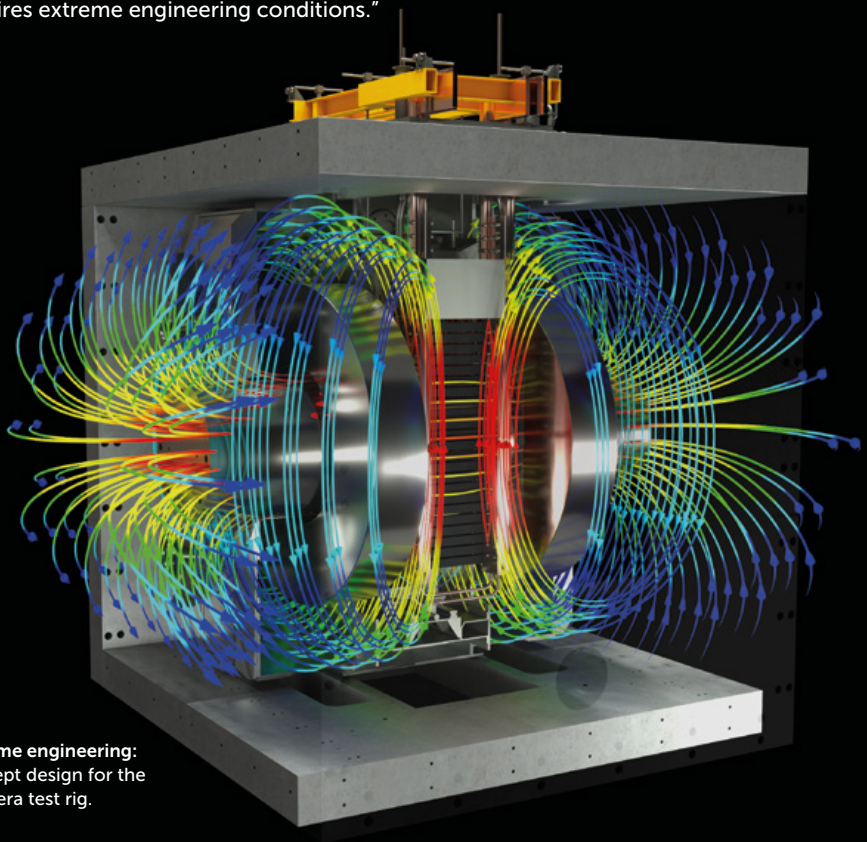
Fusion energy can be a safe and sustainable part of the global energy supply in the second half of the century, UKAEA chief technology officer Tim Bestwick told delegates from the regional supply chain and research partners at the launch event.

"We need to go 10 times hotter than the sun to get fusion reactions going here on Earth," he noted. "This is a reaction that requires extreme engineering conditions."

The new facility will focus on testing materials and components under those extreme conditions of heat and magnetic flux.

The jewel in its crown will be the Chimera (Combined Heating and Magnetic Research Apparatus) test rig, currently under construction by Jacobs. It will be a unique facility to simulate the conditions found within a fusion power plant – but without any nuclear reactions taking place – for testing in-vessel components such as fusion blanket sections.

World first: UKAEA's new facility in South Yorkshire.



Extreme engineering: concept design for the Chimera test rig.

Chimera's test chamber will be around the size of a fridge-freezer, within a machine measuring around four metres on each side. It will deliver surface heating of up to 500kW over a square metre – raising components to around the temperature of a tungsten light filament – as well as a static magnetic field of up to four Tesla plus pulsed magnetic loads.

Components will be analysed using optical digital image correlation and laser metrology to map 3D surface deformations and damage. Data will be used to generate and synchronise digital twins of the components, predictive models which will be crucial to the design and qualification of fusion power plants.

Chimera will be a hugely important national capability for future commercial fusion power plants, according to Damon Johnstone, head of the Fusion Technology Facility.

"For the first time anywhere in the world, we'll be testing components in conditions similar to those within a fusion plant," he said. "We need to build prototype components to make this work."

And with the first STEP plant scheduled to be online in the early 2040s, the first prototypes will need to be built within the next five years, Johnstone noted.

Designing, manufacturing and testing prototype components for Step is a huge challenge. Components must be made of materials which can survive fusion conditions, potentially including conventional steels, tungsten, novel and exotic alloys. And UKAEA needs to have an advanced manufacturing supply chain ready for when the Step programme needs it.

"We're talking about novel mixtures of materials, novel component geometries, and advanced joining and machining techniques," Paul Goodwin, head of UKAEA's manufacturing technology and equipment qualification group, told visitors.

Near-net shape manufacturing of large components by hot isostatic pressing, additive manufacturing, and joining dissimilar exotic metals are among the technologies under consideration. All will require development to bring them closer to commercial readiness – most are currently around level three of the 10-point manufacturing readiness level (MRL) scale, Goodwin noted.

The manufacturability of components will be taken into account at an early stage of the design development for STEP, with the UKAEA team drawing on manufacturing expertise from industry as well as working with manufacturing research organisations.

Open day: manufacturers and researchers at the launch event.

"We need the ability to manufacture the design," Goodwin said. "We want to eliminate as many joints as possible, so the nearer we get to net-shape the better. And we need to allow maintenance and repair."

Chimera and the other resources at the new centre will play a vital role in qualifying components to whatever codes and standards are chosen for fusion power plants in the UK, he added. While the international Iter fusion experiment under construction in France is managed to RCC-M standards, the UK is likely to use another code.

The 2,500m² Fusion Technology Facility has been funded by BEIS as part of the Nuclear Sector Deal, with an additional £2.2 million of investment from the Sheffield City Region's Local Growth Fund.

For the past decade, all UKAEA's operations have been solely based at its Culham campus in Oxfordshire. Steve Wheeler, director of fusion technology, noted that moving to Yorkshire for the new facility affected everything about the project.

"What's been fantastic about this project over the past three years is that the further we went down the road in getting this on the Advanced Manufacturing Park, the more certain we were that this is the right decision," Wheeler told delegates.

"That's because of the technology in the area, the supply chain, the businesses, and the other organisations and universities. There's a passion for developing technologies with a purpose, and that's what fits with our mission so well."

For more information on Chimera: ccfe.ukaea.uk/fusion-technology/chimera

A new report outlines how researchers and industry can tackle the material challenges of building viable fusion power plant.

The UK Fusion Materials Roadmap was developed by UKAEA and the Henry Royce Institute for advanced materials, with input from materials experts including the Nuclear AMRC's chief technology officer, Professor Steve Jones, and head of welding and materials, Will Kyffin.

It identifies five priority areas for urgent development:

- Novel materials to minimise the amount of activation in the structure of the fusion power plant.
- Compounds that can be used within the power plant to optimise breeding of tritium fuel to sustain the fusion process.
- Magnets and insulators that are resistant to irradiation from fusion reactions – especially under cryogenic conditions.
- Structural materials able to retain their strength under neutron bombardment at high operating temperatures (over 550°C).
- Engineering assurance for fusion materials – providing irradiated sample data and modelled predictions to give plant designers, operators and regulators the confidence that materials are suitable for use in commercial power stations.

The roadmap is intended to increase collaboration among UK materials researchers, and accelerate this important aspect of fusion energy development.

www.royce.ac.uk/collaborate/roadmapping-landscaping/fusion

Five sites shortlisted for first fusion power plant

UKAEA has shortlisted five sites which could host the UK's prototype fusion energy plant.

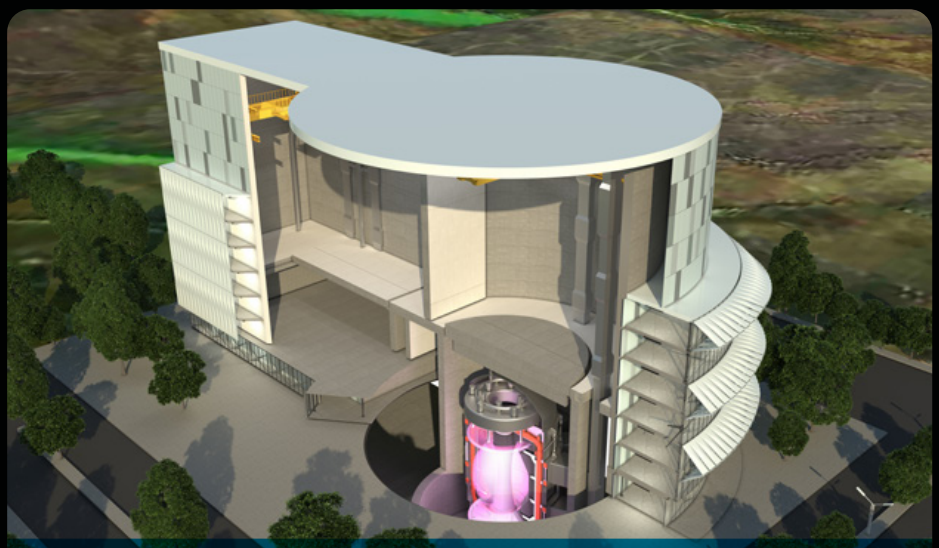
The Spherical Tokamak for Energy Production (STEP) is the UK's bid to develop the world's first commercially-feasible fusion power station. In December 2020, UKAEA invited nominations to host the prototype STEP plant, and potentially create a world-leading industrial cluster for low-carbon fusion power.

From a longlist of 15 bids announced in June, the five shortlisted sites are:

- Ardeer, North Ayrshire.
- Goole, East Yorkshire.
- Moorside, Cumbria.
- Ratcliffe-on-Soar, Nottinghamshire.
- Severn Edge, Gloucestershire.

STEP will create thousands of highly skilled jobs during construction and operation. It should also attract other high-tech industries to its host region, creating a major industrial cluster for the supply chain and research organisations.

"The shortlisting of sites is a significant step for the programme as it helps bring this challenging, long-term endeavour to life in the here and now," said Paul Methven, STEP programme director at UKAEA. "It also increases our focus as we push on with design and delivery of what we hope is the world's first fusion power plant prototype.



Giant STEP: concept design for the Spherical Tokamak for Energy Production.

"Through the next phase of assessment, we look forward to working with the shortlisted sites and local communities to gain a more in-depth understanding of the socio-economic, commercial and technical conditions associated with each site, before we make our final recommendations to the secretary of state in 2022."

STEP is a government-backed programme to build a prototype fusion energy plant in the UK. The STEP plant aims to generate net electricity, as well as demonstrating how the plant will be maintained and how it will produce its own fuel.

STEP will pave the way to the commercialisation of fusion and the potential development of a fleet of future plants around the world. UKAEA is targeting first operations in the early 2040s.

step.ukaea.uk

Have your say on fusion regulation

The UK government has opened a public consultation on regulation of fusion power, and is particularly interested in views from industry.

The move accompanied the launch of a national fusion strategy, outlining how the UK government can support the delivery of fusion energy.

Due to the expected low hazard of fusion power plants, the government is proposing to take a proportionate regulatory approach which will be distinct from the approach for nuclear fission. BEIS says the approach will allow for the safe and efficient rollout of the technology through innovation-friendly regulation.

The consultation closes on 24 December 2021.

- Fusion strategy: **www.gov.uk/government/publications/towards-fusion-energy-the-uk-fusion-strategy**
- Regulatory proposals and consultation: **www.gov.uk/government/consultations/towards-fusion-energy-proposals-for-a-regulatory-framework**

Career prospects: more than 8,000 people will soon be working at Hinkley Point C.

Nuclear jobs primed for growth

Nuclear industry employment has grown solidly in 2021, according to the latest study of jobs across the UK.

The NIA's annual Jobs Map shows that the civil nuclear sector now employs 61,371 people across the UK, an increase of more than 1,700 since 2020 – although the NIA warns that urgent investment is needed to sustain growth and ensure that critical skills are not lost as the existing nuclear fleet retires.

New build projects continue to play a vital role in sustaining employment and enhancing the UK's skills base. Hinkley Point C employs around 6,300 people on site, with more than 780 apprentices having been trained on the project to date. EDF recently announced that employment on site will rise to more than 8,000 in coming years. The proposed new build project at Sizewell C would deliver similar numbers.

North West England, with more than 24,000 jobs, and the South West, with over 12,900, remain the UK's core regions for nuclear employment.

"The nuclear industry stands alone in sustaining tens of thousands of high-skilled, well-paid jobs in zero-emissions power across the country, making a significant contribution to the UK's net-zero future," said Tom Greatrex, chief executive of the NIA. "We can have more of these jobs and these opportunities for the next generation of young people if we get a new financing model that will enable building new low-carbon power stations."

Investment in new nuclear power is supported by the major trade unions representing workers in construction, manufacturing and engineering.

"These figures show that the nuclear industry is pivotal to the government's central missions, helping to decarbonise the economy and levelling up the regions of the UK by providing tens of thousands of good quality green jobs," commented Sue Ferns, senior deputy general secretary of Prospect. "However, the looming nuclear gap caused by delays in the new build programme puts these jobs and skills at risk. We need decisive action from the government now, starting with bringing forward the legislation on the funding model for new nuclear, so that we can secure both our clean energy future and the decent employment that comes with it."

www.niauk.org/resources/jobs-map-2021

F4N
Fit For Nuclear

Quality work: inside the fabrication workshop.

Cementation Skanska

on track for nuclear fabrication

Cementation Skanska, an internationally recognised piling and ground engineering subcontractor with a growing fabrication business, is now targeting opportunities in the nuclear sector after being granted Fit For Nuclear status.

The Doncaster-based business has provided piling services for complex construction projects for over 100 years.

Leading construction and development company Skanska acquired the business in 2001, and developed it as its national hub for groundworks. When they're not working on major projects such as installing 2,000 piles for the London tunnels section of HS2, Skanska's huge piling rigs are stored and maintained at the Bentley Works facility.

Skanska has invested heavily in Bentley Works, which is now one of its most environmentally friendly sites in the UK– energy use in its 5,000m^2 of workshops has been cut by 40 per cent, and in the offices by a quarter.

"We're recognised as a leading piling and ground engineering subcontractor and, increasingly, for our manufacturing capabilities and expertise," says business development manager David Taylor. "From

Driving improvements: David Taylor and Kevin Ross.

our Bentley Works facility in Doncaster, we have the people and expertise to design and manufacture large high-integrity steel fabrications such as bridges and highways gantries. The amount of fabrication we do for ground engineering is only about 25 per cent of our work – the rest is for other sectors like construction, highways and offshore."

Taylor joined the business in 2019 from another fabrication company which he'd helped secure Fit For Nuclear (F4N) status. Arriving at Cementation Skanska, he immediately saw the potential to grow the business in nuclear across both piling and fabrications.

"Due to our Skanska culture and values – we're very strong on people and process – I thought we would tick a lot of the boxes already. It was a no-brainer to put us forwards for this," he says. "Fabrications was on this journey of growing internally and, although the procedures and requirements were already strong, I thought we could improve further. If I'd thought we weren't anywhere near F4N, we wouldn't have started, but a lot of the same values and ways of thinking were here already."

Taylor's confidence was borne out by the initial site assessment by F4N industrial advisor Kevin Ross. "Their verification score was one of the highest I've given – 92 per cent on health and safety," Ross recalls. "Their journey to granting was easier than some others. When you have a senior management team dedicated to continuous improvement, you're onto a winner."

Fabrication director Steve Joynson says the assessment was an eye-opener for the business: "The questions were different to a standard audit – they asked similar quality questions, but there's some different targets like 5S." In many areas, it was a case of "we do that, but we should look more at what we do with it," he notes.

The assessment identified a few areas for further development, primarily around better embedding processes for a wider range of work. "We're on a journey," says Taylor." Anything that improves us or gets us there quicker can only be a good thing."

As part of its F4N action plan, the team introduced a cost of quality measure to identify the root causes and costs of process failures, and drive continuous improvement to ensure that they don't reoccur.

"That's been enlightening in itself," Joynson says. "We kicked off in October, and just this year we've identified things in a different way which has opened up new doors for improvement."

For a typical fabrication business, around 90 per cent of cost-incurring quality problems are shopfloor-related. Over the past year, the proportion for Cementation Skanska has been just 10 per cent of a remarkably small total, with minimal cost impact. "That's one example of where it's made us think in a different way," says Joynson.

Cementation Skanska was granted F4N at the end of 2020, within a year of starting its journey. The business has also expanded its qualifications with the ISO 3834 certification for welding, and is one of the first companies to secure the new UKCA EN 1090 standard for structural steel.

The fabrications business has touched on nuclear projects before, with work for the ESS proton collider in Sweden, and is now engaged with a top tier contractor for Hinkley Point C. The team say that they'll start to really focus on winning nuclear opportunities from 2022.

"Having gone through that process, hopefully in the future we're going to bring some work in," Joynson says. "This isn't some short-term fix, it's something which will open up other ways to help us do things differently."

www.skanska.co.uk/expertise/specialist-capability/piling-foundations-and-ground-engineering

Deep impact: some of Cementation Skanska's newest piling rigs.

F4N
Fit For Nuclear

Brown & Holmes takes hold of nuclear opportunities

Becoming Fit For Nuclear has helped workholding specialist Brown & Holmes move into new markets, and maintain a strong order book as work in other sectors dried up throughout the global pandemic.

Tamworth-based Brown & Holmes was founded in 1939, with joint managing directors Kevin Ward and Carl Baker – both former apprentices with the company – taking ownership in 2003.

"We're primarily known as a designers and manufacturers of complex workholding solutions," says Ward. "We're recognised for the more challenging stuff that others steer clear of."

By the mid-2010s, the company was firmly established in the aerospace, automotive and power generation sectors, and started looking at the Fit For Nuclear (F4N) programme to help diversify into other markets. "We targeted getting the F4N badge and getting the company set up to be accepted as a worthy supplier to that sector," Ward says.

As Brown & Holmes progressed through the programme, they started to win nuclear work from existing clients. Aerospace work for Rolls-Royce developed into long-term work for its submarines business. A longstanding relationship with Kuka also developed as the robot supplier targeted nuclear opportunities, with Brown & Holmes now producing tooling and end effectors for decommissioning projects.

In 2018, QHSE manager Wayne Baker stepped in to lead the company's F4N journey and take Brown & Holmes through the final steps to granting.

"One or two of our nuclear customers advised that F4N would be of benefit to us, and we thought it would definitely be of benefit because there was a sector out there that was relatively unexplored for us," he recalls. "We held back a bit where we knew we needed to get the workings in place ourselves, before getting in touch again and getting the granting."

Up to the challenge: managing director Kevin Ward.

One area for further development was around safety culture, with existing practices formalised to meet the high expectations of the sector.

"We had a very good safety culture in place within the company, but F4N complements that," Baker says. "We looked at enhancing our culture, making sure we put all the documentation in place to support what we were doing. Our employees were very up for it – they're highly motivated and could see it was an advantage for us."

The firms' investment in training for its current staff of 64 included regular toolbox discussions and refresher training in nuclear requirements for workshop staff, continuing work to embed 5S culture, and leadership training for senior managers and team leaders.

The improvements are also helping the company deliver work in other sectors, Baker notes. "The disciplines we've brought in we can spin out across the board, particularly the nuclear safety culture because that's embraced in our health and safety now," he says. "It's been a rewarding learning curve for us."

Working closely with F4N industrial advisor Huw Jenkins, Baker and the team successfully brought Brown & Holmes through the final steps of the programme, with the company granted Fit For Nuclear status in late 2020.

Ward notes that the benefits of the business improvements and the growing nuclear order book was clearly demonstrated when the company's core aerospace work dried up at the start of the Covid pandemic.

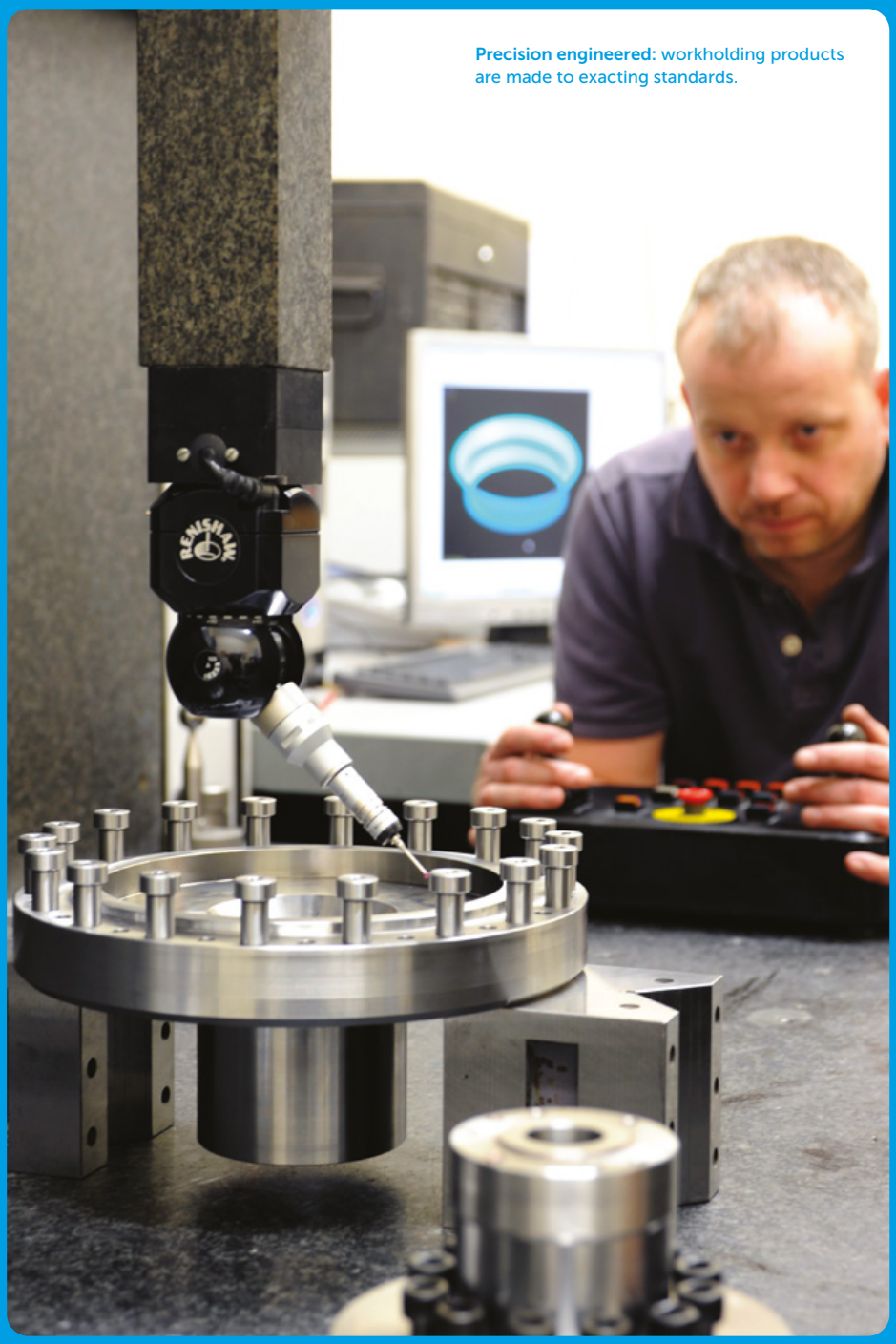
"This business would have been very quiet and in a very different position now without the ability to win business within nuclear," he says. "Almost at the same time that aerospace died a death overnight on the back of lockdowns, our nuclear work started to increase. For the last 15 months, it's been worth every penny that we've invested in nuclear. We've had a lot of successes out of the work we've supplied to the sector, and it's now time to capitalise on it and drive it forward."

Mark Haywood, business development manager, notes that the combination of F4N status and a current customer base in nuclear demonstrates the firm's ability to deliver to customer-specific regulations and standards.

"The challenges of supplying to the nuclear sector were initially daunting, but it has very quickly become second nature," Haywood comments. "The F4N granting indicates to our team, and also to our suppliers and future customers, that we understand the detail required to supply to a demanding sector."

Brown & Holmes is now actively pursuing further work within nuclear, and is gauging opportunities in areas including small modular reactors.

"Nuclear is something we've cut our teeth on now, and we're very familiar with the quality and documentation requirements of the industry," Ward says. "We've put all the hard work in, and we want to win more business off the back of that. It's work that's perfectly suited to us. The materials are more exotic than we were using 20 years ago, but we've enjoyed getting used to new materials. Our ideal order would be something that's within our capacity but perhaps pushes us to the edge a bit, to drive the business on."



Precision engineered: workholding products are made to exacting standards.

The business is also working to expand its technical capabilities. It is a member of the Coventry-based Manufacturing Technology Centre – like the Nuclear AMRC, part of the High Value Manufacturing Catapult – and collaborating on R&D projects around additive manufacturing and other technologies.

Ward sees nuclear as a thriving part of Brown & Holmes, even as work picks up again in the firm's previous core sectors. "Nuclear is going to be a massive part of this business," he concludes. "We try not to let any part of the market grow to more than 30 per cent of capacity to balance our order book, and we're going to have to grow other parts of the business to keep that balance. We're very proud of the work we're doing."

www.brownandholmes.co.uk

F4N
Fit For Nuclear

Congratulations to the latest companies to be granted Fit For Nuclear

These companies have benchmarked their performance against the standards demanded by the nuclear industry's top tiers, and driven business improvements.

Blackburn Starling manufactures low-voltage power distribution systems including motor control centres, switchboards, package substations, bus ducts and instrumentation panels.
blackburn-starling.co.uk

Carpenter & Paterson designs and manufactures pipe suspension equipment for the power generation, petrochemical, oil, gas and process industries.
www.cp-ltd.co.uk

ECS Engineering Services specialises in the bespoke design and construction of metal fabrications for water, energy and environmental management installations.
www.ecsengineeringservices.com

Inspec Solutions is an innovative and independent systems integrator, developing control, safety, automation, and software solutions across all sectors.
www.inspecsolutions.co.uk

Online Engineering Systems provides a wide range of precision machining services, specialising in development and prototype work and small to medium batch quantities.
www.onlineeng.co.uk

Powertherm Contract Services is a multi-discipline industrial service provider, offering a comprehensive range of solutions including insulation, access and site services.
www.powertherm.co.uk

Produmax manufactures precision parts and assemblies for aerospace and other quality-critical industries.
www.produmax.co.uk

Severfield (Products & Processing) provides a broad range of steelwork products and services, including staircase and other steelwork fabrication.
www.severfield.com/severfield-products-processing

Wozair specialises in the design and manufacture of high integrity heating, ventilating and air conditioning equipment for the energy sector.
wozair.com

Congratulations also to the F4N companies which have renewed their status three years after initial granting.

- Endress+Hauser
- FAUN Trackway
- Forsyths Ltd
- McEvoy Engineering Ltd
- Serimax
- Syspal

For details of all F4N-granted companies: **namrc.co.uk/services/f4n/companies**

Congratulations to the latest companies to be granted Fit For Offshore Renewables.

F4OR
Fit For Offshore Renewables

F4OR is a collaboration between the Offshore Renewable Energy Catapult and the Nuclear AMRC, based on the proven F4N model. It is being rolled out on a regional basis, with current programmes in North East England, New Anglia (Norfolk and Suffolk), and North East Scotland.

EnerMech is a specialist service company delivering integrated solutions for complex energy and infrastructure projects.
enermech.com

Proeon Systems is a specialist control and safety systems integrator providing solutions for complex and critical applications cross the energy sector.
www.proeon.co.uk

Stowen Clean Energy is a leading supplier within the offshore renewable sector, providing services from one-off inspections to large construction operations.
www.stowengroup.com

KRG Specialist Engineering Services is an established precision engineering business operating across multiple sectors.
krg-engservices.com

Tecosim Simulation, part of the international Tecosim group, specialises in computer-aided engineering simulations and numerical calculations for infrastructure industries.
tecosim.co.uk

Proeon shows the power of **people excellence**

Specialist control and safety systems integrator Proeon Systems is building on its Fit For Nuclear success with the offshore renewables programme. Lesley Swift, commercial administrator, and Phrancesca Harrison, QHSE advisor, discuss how the two programmes have helped them focus on people excellence and win new work.

People power: the Proeon team celebrate in 2019.

Despite the Covid-19 pandemic, Proeon has been very busy fulfilling our client requirements. The company works within many diverse industrial sectors, which has helped us sustain the business during this difficult time.

We are also very pleased to be one of the 15 companies from across the Norfolk and Suffolk region to secure our place in the Fit 4 Offshore Renewables (F4OR) programme. F4OR utilises the business excellence criteria from the original F4N – as we have already achieved F4N granted status, we were familiar with some of the aspects of this new journey.

We started our F4N journey in 2016, achieving granted status in November 2017. Our industrial advisor, Kevin Shepherd, helped guide us through this process which enabled us to benchmark ourselves and our management systems against the nuclear sector business excellence model. Although we already had mature management systems, this helped us to refine our existing practices.

The F4N programme also helped us identify that our mature process model was meeting the business excellence criteria. However, our people excellence score was much lower than we had anticipated, something we had completely overlooked. We feel this is something the ISO standards do not focus enough on.

The next step was to set about identifying actions to improve our performance in this area. If we are completely honest, this was the most value we got from the F4N scheme – realising that people are our main product.

At this point we relied heavily on Kevin Shepherd who, as a people person with a great deal of experience, helped inspire us to invest our energies in this particular area.

One of the main benefits came from implementing employee consultation surveys, which we anonymised to enhance disclosure. The feedback was challenging but massively beneficial to our business, enabling us to identify additional areas for improvement.

We were also able to refine our existing continual improvement forum, which empowers our employee stakeholders to identify areas of improvement. This process involves employee representatives who bring ideas from their teams to be discussed and reviewed with a cost benefit analysis. Engagement with this monthly forum has helped us improve communication throughout each area of the business.

This scheme also helped us bridge the gaps between operations and the management systems of the business – as is often the case when businesses grow, this can become strained. The elements of the people excellence model assisted us in maintaining a closer relationship between the two areas. We actively sought to bridge this gap by sharing the business strategy with our employees and emphasising our core values on a regular basis, to ensure we are all singing from the same hymn sheet.

We took the decision to visually address these needs by having our core values and mission statement printed and installed on the walls throughout our facility. We have taken further steps by implementing display screens containing rolling presentations with standard business information. Each area is able to tailor additional content to their specific needs.

During the course of our F4N journey, we were successful in securing a project to develop a replacement crane control and drive system for a UK nuclear power facility. The crane system was over 20 years old, and there were issues around the obsolescence of the drives and the control systems. Proeon often works where control and automation are critical and complex, and this project was a prime example of this.

Working closely with the client and with no margin for error, we were successful in ensuring a safe and continued operation of this crane upgrade, providing a full turnkey project that will be supportable for the next 20 years.

www.proeon.co.uk

F4N
Fit For Nuclear

The new standard for **nuclear quality**

In June 2021, Ansaldo Nuclear became the second UK manufacturer to achieve the new ISO 19443 nuclear-specific standard. Key account manager Alan Bevan, assurance manager Dave Rasdell and HSE manager Keith Roeton explain how the company built on its Fit For Nuclear journey to achieve the new standard.

Setting the standard: inside Ansaldo Nuclear's workshop.

Our journey started way back in 2016 where we worked with Nuclear AMRC on our original F4N assessment. ISO 19443 was still a draft document back then, but it caught the attention of our senior leadership team.

ISO 19443 applies the principles of one of the world's most renowned quality standards to the nuclear sector. It combines best practice in quality with the specific requirements of the nuclear industry.

Fast forward to September 2019, and the decision was made to proceed with certification.

Our starting point was to review the standard and undertake a gap analysis against each clause. From this, an action plan was established with key actions and action owners.

Our next step was to contact our certification body, LRQA, who already had experience with this standard. The certification would be exactly the same as for other management system standards.

First, we would have a Stage 1 assessment which looked at the overall system to see if all of the management system elements are there and working.

A Stage 2 assessment would then be required to drill right into the detail of the standard and our processes. To undertake the assessment, we needed an assessor, and this proved a bit of a challenge in its own right as currently there are not many assessors with 19443 experience.

Eventually we were allocated an assessor and a Stage 1 date. Our preparation then focused on this date as we worked through our action plan. The Stage 1 visit was quite detailed and intense, but went smoothly with four minor findings.

Our Stage 2 assessment was for three days, which gave us time to address the initial findings. These three days were, again, detailed and intense as our assessor drilled down into our processes. At the end of this stage, we had four open non-conformance reports, and were recommended for certification.

Following a technical review with LRQA, we received our formal certificate in May 2021.

Currently, ISO 19443 is not an accredited standard by UKAS, as there isn't the take up for certification to justify accreditation. However, the certification process is exactly the same and just as stringent. As an early adopter of the standard, we believe this will give us some advantage moving forward.

As our managing director Andrea Basso said: "ISO 19443 is perfectly aligned with Ansaldo's vision and mission. Engineering excellence coupled with a strong safety culture are core to delivering safe, reliable solutions to the nuclear sector. Our quality management system provides the framework for our activity. The achievement of ISO 19443 certification demonstrates we have all the necessary underlying processes in place to ensure our work is right first time, every time."

ISO 19443 improves the understanding of quality requirements by suppliers and encourages nuclear industry players to work in the same direction. It is a win-win standard because it gives buyers the assurance of a standardised level of quality while securing nuclear safety and quality for those in the supply chain. ISO19443 is aligned with the many regulatory and industrial local and international requirements, and allows organisations to better manage risks and improve their performance.

www.ansaldoenergia.com/AnsaldoNES/home

Taking the skills message to **Westminster**

In September, four members of the Nuclear AMRC team took part in a nuclear skills and apprenticeships fair in Westminster. Lucy Birchall, working at the centre through the nucleargraduates programme, explains why investment in young nuclear workers is so important.

On Tuesday 14 September, I attended the Skills and Apprenticeships Fair which formed part of Nuclear Week in Parliament. The aim of this event was to promote the necessity of the civil nuclear industry in achieving net zero emissions, and highlight the importance of bringing young people into this industry.

MPs were invited to the event to learn about the industry and meet young people on apprenticeships and graduate schemes. This was a fantastic opportunity to present the work of the centre and the industry as a whole.

Many companies from the industry were represented at this fair, each having their own stand at which other attendees were able to ask questions and network. Running the Nuclear AMRC stand were myself, Neil Murray, Dr Rahul Mandal and Dr Paul Wrigley. We had a lot of interaction with people from across the industry, from close partners of the centre to new apprentices just starting out at nuclear sites across the country.

For me, the highlight of the afternoon was a speech from NSAN's nuclear apprentice of the year, Katie Wightman from Sellafield Ltd.

Katie gave an inspiring speech about how undertaking an apprenticeship has given her opportunities she never thought she'd have, having struggled with exams at school. She also highlighted some of the challenges still to be faced by stating that she is the only female in her plant-based team. Seeing another young woman speaking passionately about her experiences in the industry was the best possible advert for why apprenticeships and graduate schemes are necessary for getting more young people into the industry.

Young team: the Nuclear AMRC team at the Westminster skills fair.

This event was also the launch of the NIA's 2021 Jobs Map (see p17) which details the spread of nuclear workers across the country. Having a visual representation of nationwide impact of nuclear on jobs and opportunities is a useful tool to highlight to all MPs why nuclear is relevant to them and their constituents.

During the afternoon we spoke to Trudy Harrison, MP for Copeland, the constituency which includes Sellafield. She was very interested in the work of the centre and also asked many questions about the nucleargraduates scheme.

As a nucleargraduate, I have been privileged to have seen a lot of the industry in a short period of time. My second secondment was at the Department for Business, Energy and Industrial Strategy (BEIS), working on radioactive waste policy. Spending time working within BEIS opened my eyes to the challenges faced by policy makers, and gave me an insight into how decisions about the industry are made at the highest level. Because of this, I was very happy to attend Nuclear Week and support those who are making policy by showing MPs why nuclear is important.

Attending this event was a fitting end to my time at the Nuclear AMRC, and I felt privileged to be able to promote the incredible work done at the centre to everyone from MPs to newly started apprentices.

www.nucleargraduates.com

SHIFTING PERCEPTIONS OF LOW-CARBON POWER

A new video and social media campaign led by the Nuclear AMRC and Nuclear Industry Association (NIA) aims to move the public perception of nuclear power as part of the low-carbon energy mix.

With the UK government now aiming to decarbonise all electricity generation by 2035, nuclear will continue to play a critical role in reaching net zero greenhouse gas emissions. But while government and the energy industry are increasingly acknowledging the need for new nuclear, public perceptions are still sceptical.

Even if people aren't hostile to nuclear, they often don't appreciate its low-carbon credentials or the need for baseload power alongside variable renewables.

It's a particular challenge among younger generations, who might be fully committed to decarbonisation but don't see nuclear as part of the solution. A 2020 survey by the Institution of Mechanical Engineers found that people aged between 18 and 24 are the least likely to understand that nuclear is a low-carbon power source.

The new 90-second video introduces the arguments for nuclear power, and highlights support from organisations which aren't led by the nuclear industry – from the UK's independent Climate Change Committee to the International Energy Authority.

To watch the video and find out more, go to: **namrc.co.uk/netzeroneedsnuclear**

Nuclear Manufacturing Summit 2021

16–17 November 2021

This November, the Nuclear AMRC is hosting a major supply chain conference to help manufacturers connect with the opportunities in major nuclear programmes – from Hinkley Point to SMRs, decommissioning to fusion.

The UK faces a monumental challenge to decarbonise by 2050. With up to 40GW of new nuclear capacity under discussion – a potential investment totalling hundreds of billions of pounds – there will be huge opportunities for the supply chain.

From current gigawatt-scale projects to new designs of small and advanced modular reactor, along with continuing opportunities in the decommissioning and defence sectors, the potential scale of the market will stretch the nuclear supply chain's capabilities and capacity to the limit.

Hosted by the Nuclear AMRC, this event is for supply chain companies looking for opportunities in the nuclear market at home and worldwide, and wanting to play a part in the UK's commitment to reach net zero emissions.

The conference features leading speakers from key programmes in new build, advanced reactor development, decommissioning and more, including:

- Sizewell C
- Moltex Energy
- UKAEA
- Sellafield
- Rolls-Royce SMR
- U-Battery
- Tokamak Energy
- Magnox

The two-day event also includes one-to-one meetings between manufacturers and buyers to really explore the opportunities for your business – plus an industry exhibition, networking drinks and dinner, workshop tours, and more.

For full details and registration: **nuclearmanufacturingsummit.co.uk**

Work **with us**

The Nuclear AMRC is here to support manufacturing companies, from SMEs to global giants, which are seriously interested in winning business in the nuclear sector.
If we can help your company, we want to hear from you.

We help manufacturers through **supply chain development** and **innovation**.

We can work with you to raise your quality, capability and cost competitiveness to meet the needs of the global nuclear industry.

And we can develop world-leading manufacturing processes and technologies. We have the production-scale facilities and the manufacturing expertise to help you improve cycle time, reduce lead time, improve quality and reduce costs.

Our capabilities and services are open to all UK manufacturers. We provide a responsive service to help you solve your manufacturing challenges and win new work.

We also offer full membership, giving you access to our generic projects and the opportunity to determine our core research.

To find out more about how we can help you win work, contact the Nuclear AMRC business development team:
business@namrc.co.uk

NUCLEAR **AMRC**
ADVANCED MANUFACTURING RESEARCH CENTRE

The University Of Sheffield.

MANCHESTER 1824
The University of Manchester
Dalton Nuclear Institute

Contact us:

Nuclear AMRC
The University of Sheffield
Advanced Manufacturing Park
Brunel Way, Rotherham, S60 5WG

tel: +44 (0)114 222 9900
email: enquiries@namrc.co.uk
online: namrc.co.uk
twitter: @NuclearAMRC

Nuclear AMRC Midlands
iHub, Infinity Park, Derby, DE24 9FU

Manufacturing Technology Research Laboratory
The University of Manchester
Sackville Street, Manchester, M13 9PL

Tier 1 members:

Canadian Nuclear Laboratories · cavendish nuclear · EDF · EPRI Electric Power Research Institute · framatome · HEXAGON Manufacturing Intelligence · ITW Welding · Jacobs · NDA Nuclear Decommissioning Authority · NIA Nuclear Industry Association · Rolls-Royce · Sheffield Forgemasters · ULTRA · Westinghouse

Tier 2 members:

AMI · CENTRONIC · CODRA Software Ltd · Frazer-Nash Consultancy · Fronius · Argyll Ruane · INSPHERE · Johnson & Allen · KTIG Keyhole TIG Welding · MAHER · SPARC · NSAN · NIKKEN · NUVIA · POLYSOUDE The Art of Welding · pro beam · ptc · Quaker Houghton Forward Together · Red-D-Arc Weld Automation · SANDVIK Coromant · SolidCAM The Leaders in Integrated CAM · South West Nuclear Hub · starrag Starrag Group · TSP Engineering · TVC · VIRTALIS Connected Immersive Visualisation · WB Alloys

Supported by:

HM Government · European Union European Regional Development Fund · National Nuclear Laboratory · nof energy · EIC · Regional Growth Fund · UKRI Innovate UK · the nuclear institute · NuScale Power

If you'd like to receive a subscription copy of *Nuclear AMRC News*, or would like to update your current details, please contact: t.chapman@namrc.co.uk