NUCLEAR AMRC news
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CATAPULT
High Value Manufacturing

Rising talent: the business secretary meets young engineers and apprentices at the Nuclear AMRC.

Business secretary hails **new generation of power**

Business secretary Greg Clark MP visited the Nuclear Advanced Manufacturing Research Centre to see the centre's work in supporting the next generation of nuclear power and delivering the nuclear sector deal.

During a tour of the Nuclear AMRC workshop, Clark saw a range of advanced machining, joining and robotic technologies which can significantly increase productivity in the manufacture of a new generation of small and advanced modular reactors.

"This cutting-edge facility in Sheffield is pioneering innovative nuclear technology of the future, as the UK continues to seize the opportunities of moving to a greener, cleaner economy through our modern industrial strategy," Clark said.

"The UK was the first domestic nuclear power country in the world and this government commissioned the first new nuclear power station in over a generation. The development of small modular reactors as part of our landmark £200 million nuclear sector deal could unlock more jobs and more local growth."

Published in June, the nuclear sector deal supports a variety of initiatives to create a more competitive supply chain, using advanced manufacturing technologies to win work in the UK and worldwide. In return for funding support of up to £200 million total, the industry has committed to significantly reducing costs in nuclear new build and decommissioning, and growing the pool of skilled employees by improving gender diversity.

During his visit on 25 October, Clark was shown workpieces from an ongoing project to reduce production time for a

small modular reactor pressure vessel. These include pressure vessel sections which have been joined by electron beam welding (see below), a technique highlighted in the sector deal as offering significant productivity and quality improvements by reducing weld cycle times from days to hours.

"The Nuclear AMRC is playing a vital role in delivering advanced manufacturing techniques and developing the supply chain for the nuclear industry," commented chief executive officer Andrew Storer. "I was delighted to show the Secretary of State some of our world-leading capabilities for industry-led research and development, which are part of the key to achieving the ambitious targets of winning work in the UK and overseas in the nuclear sector deal."

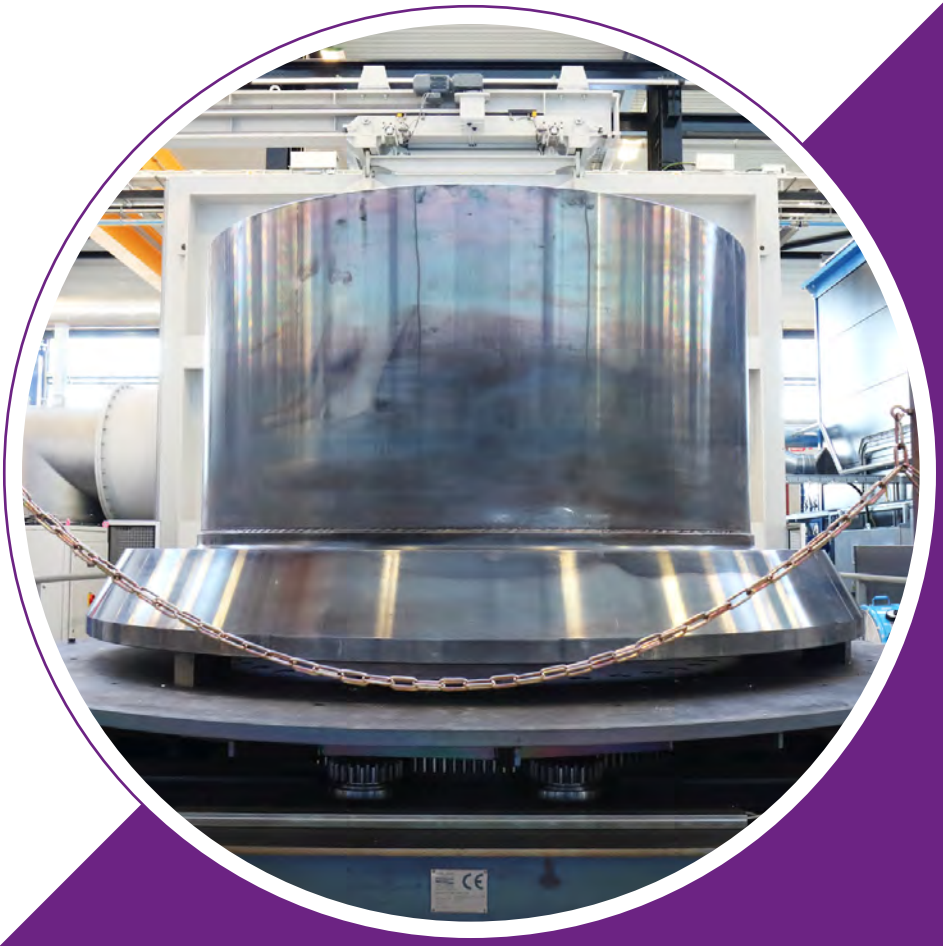
Clark and Storer also discussed the centre's work to improve the competitiveness of the UK supply chain, including proposals to expand and develop the established Fit For Nuclear (F4N) programme. Around 1,000 companies have already engaged with the programme, with 145 now granted F4N status after driving business improvements with support from the Nuclear AMRC.

An expanded national supply chain development programme, backed by the nuclear sector deal and linked to advanced manufacturing and construction R&D, could create or sustain up to 12,500 jobs and up to £2 billion domestic and international contract wins by 2030.

"Our supply chain development programme has already helped hundreds of companies become more competitive, and we're planning to expand that to help even more companies win work in nuclear," Storer noted.

Clark also met some of the centre's young engineers and apprentices during his visit.

"Diversity is a really important and provides confidence that we are developing scientists and manufacturers for the future," Storer said. "I was really pleased to introduce our apprentices and allow them to explain what they aspire to become."



Technology of the future: Greg Clark and Andrew Storer tour the Nuclear AMRC workshop.

During his tour of the Nuclear AMRC, business secretary Greg Clark was shown a series of large workpieces from an international project to manufacture a two-thirds scale prototype of a small modular reactor pressure vessel.

This section includes the lower shell and flange, joined in the centre's electron beam welding chamber in a single pass. Total welding time for the join, with an outside diameter of 1.8 metres and wall thickness of 80mm, was just two hours. Using conventional submerged arc welding, the same join would take around 10 days.

The work is part of a four-year collaboration with the US Electric Power Research Institute (EPRI) to develop new manufacturing and fabrication methods for reactor pressure vessels. The project aims to reduce the total time needed to produce a SMR pressure vessel from around two and a half years to less than 12 months.

The project is funded by the US Department of Energy, and involves industrial partners on both sides of the Atlantic including Sheffield Forgemasters. The vessel design is based on NuScale Power's 50MW Power Module, but the techniques being developed could be applied across a wide range of advanced reactor designs.

The Nuclear AMRC also exhibited the welded section, along with a pressure vessel head clad using diode laser technology in less than two hours, at a BEIS conference on commercialising small nuclear in the UK, held in Coventry in early November (see over).

Manufacturing R&D funding to target **SMR development**

Companies will be invited to submit initial applications for a share of £32 million of funding for nuclear manufacturing and construction research before the end of the year.

Nuclear energy minister Richard Harrington confirmed the plans at a government-backed conference on commercialising small reactors in early November.

The advanced manufacturing and construction programme, announced in the nuclear sector deal in June, aims to kickstart the supply chain for small nuclear projects. Companies will be able to bid for funding to try out new technologies and techniques associated with new reactor designs, and iron out any flaws with demonstration models before they begin commercial production.

The programme is intended to support a number of representative-scale build projects using factory-build techniques, modular and advanced construction processes, digital engineering and other methods. These collaborative projects will bring together the industry's top tier with manufacturers, universities and specialist research centres, with the results fed through the UK supply chain. Research should target technologies and components which offer the greatest value for UK manufacturing, with companies encouraged to work with the nuclear regulators to ensure that new processes and products meet regulatory requirements.

Harrington also announced that developers of small and advanced modular reactors would be invited to submit their design proposals to the UK regulators in the new year. Any new designs will have to pass the generic design assessment (GDA) process operated by the Office for Nuclear Regulation and Environment Agency, which allows a reactor design to be built at multiple sites in the UK.

Around 200 people from industry, finance and academia attended the 'Commercialisation of small nuclear in the UK' conference, held at the Manufacturing Technology Centre (MTC) in Coventry. Speakers included Nuclear AMRC programme director Jay Shaw, who presented alongside MTC director Neil Rawlinson on how manufacturing innovation can be best applied to the SMR market.

For the latest information: **www.gov.uk/government/publications/advanced-nuclear-technologies/advanced-nuclear-technologies**

Five-year funding for HVM Catapult

The government has confirmed ongoing funding for the High Value Manufacturing Catapult network of industry-led research centres, including the Nuclear AMRC.

The HVM Catapult consists of seven specialised R&D centres, and aims to improve the UK's performance in translating the strengths of its world-leading research base into the goods and processes which equip the UK's high-value manufacturers for success in challenging global markets.

"The HVM Catapult is perfectly placed to make a full contribution to a successful UK industrial strategy," said Dick Elsy, chief executive officer of the HVM Catapult. "In our first six years of operation we have established a proven track record, generating investment in R&D and driving improvements in manufacturing productivity and competitiveness. The five-year funding package allows us to build on our early successes, broadening our productivity impacts while equipping British firms with the manufacturing innovation they need to compete in uncertain and challenging international markets. Our support has never been more needed."

The Nuclear AMRC will receive up to £46 million funding over the next five years. The funding will allow the centre to expand its services to UK manufacturers, and develop new capabilities at its core research factory and its growing network of regional facilities.

"Our Catapult funding gives us a secure base to expand our services to UK manufacturers, and work with even more companies to help them innovate and compete," said Andrew Storer, chief executive officer of the Nuclear AMRC. "We are set to play a key role in delivering the nuclear sector deal agreed by government and industry earlier this summer, and are investing in our facilities in Rotherham, Birkenhead and Derby to help UK manufacturers win work in the nuclear supply chain at home and worldwide."

Under the Catapult funding model, each centre will match its core funding with commercial investment from companies, and from external funding for collaborative R&D projects.

The funding is part of a major investment across the Catapult network of centres focusing on areas including energy systems, offshore renewable energy, cell and gene therapy, satellite applications, and compound semiconductors.

hvm.catapult.org.uk

Executive **view**

Innovation and transformation

At the start of 2018, I said this would be a transformational year for the sector. Looking back, it feels like we have come a long way but still have a way to go.

I reflected over the year on the overarching messages about cost, pace and collaboration. Nuclear has no given right to be the energy choice of the future. We have to demonstrate that nuclear power is affordable next to other low carbon technology, and that we can deliver it in the timescale required to replace the UK's current fleet and create additional capacity for future needs.

Innovation can provide part of the answer. Introducing innovation to reduce cost and increase export potential needs a technology pull as well as innovation push, which is difficult if the technology is fixed against a largely agreed supply chain plan. Making sure we develop a technology that enables the implementation of innovation will also create vital export opportunities.

It's not just about game-changing innovation. Through our Fit For Nuclear programme, we often get involved in reducing costs through basic measures such as reducing delays from defects, reducing the amount of waste going into skips, and improving the efficiency of factories and working practices.

We need to ensure we work better across the nuclear sector to share best practice, and take good work from other industries. We work with suppliers from many other sectors and find a lot of examples of good practice. We still have a challenge to cut out duplication, and start to collaborate much more, although I do thing this is improving in some areas. We spend a lot of time and money competing, which will ultimately be added to the contract and make the UK less competitive. This also applies in the academic research world – I am often surprised how many similar projects are being developed in different universities with government funding.

This summer saw the launch of the nuclear sector deal as a framework to support new build, decommissioning and advanced technologies. Implementation has now begun. The Nuclear Industry Council agreed five topics – 30 per cent cost reduction in decommissioning, 20 per cent cost reduction in new build, UK winning business, skills, and innovation – each led by someone identified and agreed by the council. Given our role to help UK companies win work, I am pleased to be leading the "UK winning business" topic.

As part of the deal on supply chain development, we are preparing to launch a significant extension of our successful Fit For Nuclear programme. This will get into the heart of some competitiveness topics, and help companies prepare to win and deliver in the nuclear sector. We are engaged with many current F4N companies and the companies we worked with in the Civil Nuclear Sharing In Growth programme.

The sector deal also outlined eight advanced modular reactors (AMRs) which have received initial funding for feasibility studies. These will be down-selected to two that will continue through to concept stage. I am pleased that we are now supporting most of these technologies, and look forward to seeing how things progress through 2019.

I'm also looking forward to hearing more on small modular reactor (SMR) development following the BEIS event in early November, including potential support through the Industrial Strategy Challenge Fund.

Also, let's not forgot that we are world leaders in fusion technology. I am sure we will see more development here through next year, with further funding announced in the recent Budget.

Greg Clark visited the Nuclear AMRC in October and, like most visitors, was impressed by what he saw and what we are trying to do. It was clear he understands the challenge of implementing innovation, and also clear he wants the UK to succeed with export.

If we run into 2019 at the pace we are finishing 2018, I feel confident that we will continue to transform things in the right way. Just increasing the diversity in our sector will ensure we are setting ourselves up for the next few decades – after all, decisions made in 2019 will be delivered by today's young generation, and we need to provide a modern environment that they understand and want to work in.

We need people with passion to drive improvement and take decisions forward. And I want to congratulate one of our researchers, Rahul Mandel, on his Great British Bake Off success. Many in the centre have lived and breathed every cake throughout the summer – I know my waistline has suffered as a result. It just shows what can happen when passion is applied and directed.

Andrew Storer, chief executive officer, Nuclear AMRC.

Open house for **disk laser welding**

The Nuclear AMRC's disk laser cell opened its doors to manufacturers and researchers, as part of an open day with industrial laser specialist Cyan Tec Systems.

The cell features a 16kW Trumpf disk laser, the most powerful of its kind in the UK. It was designed and built by Loughborough-based Cyan Tec, and commissioned at the start of the year.

During the open day in early October, around 35 delegates enjoyed an exclusive look at the cell with Cyan Tec engineers, a tour of the Nuclear AMRC workshop, and presentations from both organisations.

The Nuclear AMRC's disk laser cell is designed to produce high-quality deep penetration joins over lengths of a metre or more. The laser head is carried by a six-axis gantry over a two-axis manipulator table which can carry components up to 15 tonnes, all contained in a safety enclosure measuring 10 by seven metres and eight metres height.

"It's a machine we're very very proud of," Clayton Sampson, Cyan Tec chief executive officer, told delegates. "It's a very capable machine, and offers a huge number of advantages for aerospace and automotive, in terms of sheer penetrative power – it goes up to 20mm and is able to weld different types of metals."

The Nuclear AMRC team are initially investigating the laser's use in welding seams on large intermediate-level waste containers for the nuclear decommissioning sector.

Laser welding promises to significantly reduce manufacturing times and costs while maintaining a high quality of weld seams. Thanks to a strictly localised high-energy input and high travel speeds, the laser produces a much lower heat input than most other welding technologies, significantly reducing thermal stress and distortion.

Seeing the light: delegates visit the disk laser cell.

The cell can also deliver a simultaneous gas-tungsten arc weld for hybrid welding, which can offer a better fit-up tolerance than laser alone with less heat distortion than arc alone. The technique is used in the shipbuilding industry to join steel plates.

Cyan-Tec specialises in bespoke high-power laser systems for industrial applications, including joining, cutting, ablation and cleaning, deployed on a variety of robotic and flatbed platforms. The company is currently developing a standard cell featuring a fibre laser and six-axis industrial robot for welding three-dimensional components, for launch in 2019.

cyan-tec.com

New members

Welcome to the latest companies to join the Nuclear AMRC as tier two members.

Curtiss-Wright is a US-based engineering group with more than 50 years' experience in the commercial nuclear market. It operates an installed base of products at all US nuclear plants and many international facilities, and supplies reactor coolant pump technology for the Westinghouse AP1000 and other reactors. **curtisswright.com**

Atlas Composite Technologies develops and manufactures next-generation composite structures for demanding applications in the aerospace, motorsport, defence, satellite communications and R&D sectors. Based in Ilkeston, Derbyshire, Atlas will work closely with the Nuclear AMRC's new Derby facility. **www.atlascomposites.com**

For more information about membership: **namrc.co.uk/services/membership**

Flexible approach to robotic machining

The Nuclear AMRC has commissioned a new robotic cell to develop intelligent automated techniques for machining and inspecting large components.

Robot trials: research engineer Ben Rae works with the new Stäubli arm.

The cell features a new Stäubli TX200 six-axis industrial robot, equipped with a choice of force-controlled pneumatic spindles for grinding, deburring and polishing operations.

Automation specialist Stäubli Faverges provided the robot as part of the Coroma project, a €6 million, three-year international collaboration to develop intelligent robotic systems for a range of manufacturing tasks. Funded through the European Horizon 2020 programme, the Coroma consortium includes 16 international partners from seven countries.

Nuclear AMRC research engineers Ben Rae and Ozan Gurdal are using the TX200 to develop robotic techniques for two common tasks in nuclear manufacturing. The first is grinding and deburring the welded joins on a stainless steel fuel rack assembly – when done manually, this is a time-consuming process with vibration-related health risks for the operator.

The second task is removing the large burrs from fuel tubes which have been joined by friction stir welding.

The team have now completed initial cutting tests to investigate the performance of the pneumatic spindle under different cutting conditions, using an accelerometer to help monitor tool wear.

"We're using the accelerometer to measure the tool speed before and after the cut, so we can correlate the drop in speed with how much force it's exerted on the part," explains Rae. "We've successfully measured the speed inside and outside the cut – it wasn't clear that we would be able to do that because of all the vibrations going on."

As with other robotic machining platforms, the arm has much less dynamic stiffness than a regular machining platform, so ensuring accuracy is a major challenge. The robot is accurate to around a millimetre – better than a human operator, but not as precise as a CNC platform – and can tend to drift off the workpiece.

But even if the robot does drift, the pneumatic spindle fitted to the Stäubli can help provide constant cutting force. "The pneumatic spindle is sprung," Rae says. "You can place it at an angle so that, if the robot drifts on and off the part, in theory it should still be applying constant force to the part."

The deflected spindle can complicate the relationship between tool speeds and material removal, and the team are now carrying out further cutting trials to better understand its behaviour. They will also investigate ways to maintain a constant material removal rate by automatically adjusting the feed rate, and methods to identify optimal cutting speeds while avoiding chatter.

Safety is also a vital factor, and the team are testing a variety of cost-effective safety features to ensure that humans and robots can work together with no risk of injury.

The Coroma project is developing a host of robotic manufacturing techniques, with the aim of making them easier to use in different applications. The Nuclear AMRC team have already developed a measurement and control interface which uses a laser scanner to generate a surface model of the welds and identify excess material which must be removed to meet quality standards. They are now developing methods to allow the toolpath to be generated automatically from this scan data, which will allow the robotic machining techniques to be easily applied to a wide range of products.

"The whole project is looking at ease of programming, so you won't have to spend weeks programming the system for each new component," Rae notes.

www.coroma-project.eu

Nnuman community linking research with industry needs

Nuclear manufacturers and researchers are invited to join a new forum supporting the development of the next generation of nuclear technology.

Around 50 technical experts from the nuclear industry, academia and the High Value Manufacturing Catapult met at the AMRC Knowledge Transfer Centre in October, for the second meeting of the Nnuman community.

The community promotes networking for nuclear manufacturing research, development and deployment, and provides new opportunities for collaboration, cross-disciplinary working, project proposal development and information exchange.

The group developed from the industry-led technical advisory board for Nnuman (New Nuclear Manufacturing), a £8 million, five-year EPSRC-funded programme which ended last year. The programme was led by The University of Manchester Dalton Nuclear Institute with support from the Nuclear AMRC and National Nuclear Laboratory.

Nnuman addressed new R&D capabilities to support the future needs of the UK and global nuclear industry, in areas including joining, advanced machining, near-net shape manufacture, and product performance.

"Nnuman originally looked at new manufacturing techniques such as electron beam welding and surface engineering, but we're now using Catapult funding to extend the original remit of Nnuman into the complete nuclear landscape," says Professor Steve Jones, Nuclear AMRC chief technology officer and chair of the Nnuman community.

"We're now readying the community to be prepared to look at how some of these identified technologies and research programmes can support the manufacture of light-water SMRs, Generation IV fission reactors, fusion reactors and advanced decommissioning and storage techniques. This will only be completed if the pan-engineering, manufacturing and academic communities can meet the challenges, and accelerate those ideas and concepts from academia and research into industry in a suitable timeframe."

Sharing expertise: Nuclear AMRC technical lead Matt Smart presents to the Nnuman community.

The October meeting featured presentations and discussions on topics including materials for advanced reactors, condition monitoring, powder metallurgy for additive manufacturing, and advanced joining and machining technologies.

The Nnuman community meets twice a year, and operates on a volunteer basis. "We are looking to engage with all relevant interested members of academic, engineering and manufacturing organisations who wish to develop relevant funding streams, extend their knowledge and operating capabilities, while simultaneously expanding their network of solution providers," Jones says.

For more information about joining the Nnuman community, contact: **steve.jones@namrc.co.uk**

namrc.co.uk/services/nnuman

Building expertise for **additive repair**

Nuclear AMRC researchers have completed a detailed analysis of Inconel alloy for additive repair, as part of an international project to develop new techniques for mechanised repair of aerospace components.

Crack team: NDT lead John Crossley and additive manufacturing lead Udi Woy inspect a sample with intentional defects.

Flaw show: a test plate with a variety of damage and defects.

The work is part of a collaborative European-Canadian project called Amos (Additive Manufacturing Optimisation and Simulation platform for repairing and remanufacturing of aerospace components), led by the Nuclear AMRC. The project involves nine partners from Canada, France, Sweden and the UK, who bring together a range of direct energy deposition (DED) additive technologies using aerospace alloys.

"DED is a flexible process for repair, with a lot of appeal to the aerospace and heavy engineering industries," says Udi Woy, technical lead for additive manufacturing at the Nuclear AMRC. "For applications of this size, flexibility is a significant factor. If you consider aero engine repairs, DED tools can be conveyed to the component, and material can be precisely deposited where it is required."

The Nuclear AMRC's research for Amos has focused on arc and laser DED with the nickel-chromium superalloy Inconel 718 in wire and powder form.

"We've developed a comprehensive matrix for the tensile, low-cycle fatigue and crack propagation testing of about 300 samples," Woy says. "This has enabled us to generate huge amounts of metallurgical data for quantifying the variations between conventional, as-built and repaired materials. We're also investigating the interface integrity, performance and predictability of these materials in different orientations, and how this data can facilitate the development of DED repair standards."

The other Amos partners are meanwhile investigating titanium 6-4 alloy, in wire and powder form, and AerMet 100 high-strength stainless steel powder.

The Nuclear AMRC team are now working with samples featuring a series of intentional defects, produced by GKN Aerospace in Sweden. The samples have been scanned using an innovative inspection process developed by Canadian partners Liburdi and McGill University, and the Nuclear AMRC's non-destructive testing specialists are benchmarking the new technique against current practice.

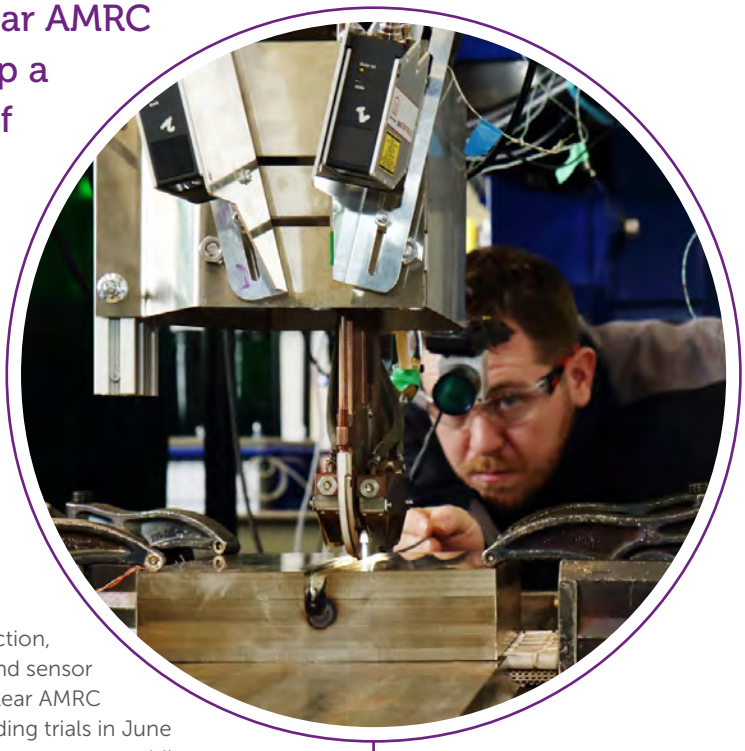
"We're looking at how to automate the process of detecting defects to facilitate DED repairs," Woy says. "We can now identify certain types of defects such as voids and tool marks relatively easily, but cracks are more challenging."

Amos is a €2.6 million, four-year collaboration between European and Canadian aerospace manufacturers and researchers. The project launched in May 2016 with support from the European Horizon 2020 programme and Canadian funding agencies CARIC and NSERC.

www.amos-project.com

Simple steps towards **single-platform manufacturing**

Welding trials are underway at the Nuclear AMRC as part of an ambitious project to develop a single manufacturing platform capable of performing a range of machining, fabrication and inspection operations for large nuclear components.



Simple test: welding technician Liam Webster prepares a trial run of the narrow-groove welding head with laser sensors, microphone and thermal camera.

Single platform manufacturing reduces the need to move large components between work areas, and helps ensure accuracy and quality control throughout the manufacturing process. Developing a wider selection of integrated machining, cladding and inspection tools which could be deployed on a single large manufacturing platform, and using Industry 4.0 techniques to analyse and act on large amounts of real-time data, could achieve cost and time savings of at least 50 per cent for a range of complex fabrications.

Potential applications include nuclear components such as pressure vessel sections, large valve casings and decommissioning waste containers. The technology could also reduce the risk of manufacturing error and cut cost and time for smaller high-value components for the nuclear island, and be deployed in other sectors such as energy, oil and gas, marine and aerospace.

To prove the feasibility of the approach, the Nuclear AMRC is leading the Simple (Single Manufacturing Platform Environment) project to develop an integrated welding and monitoring tool.

The tool combines a range of sensors and testing tools with a mechanised arc welding head. This will allow automated in-process inspection of welds, improving quality and reducing the risk of weld failure leading to costly rework.

"Having an autonomous welding system, where you don't need a skilled engineer right up against the weld, is a key enabler for single platform manufacturing," says Matt Smart, technical lead for the Simple project. "It allows interoperability between different manufacturing processes. This system will ensure the quality of welds and allow the part to remain on the machine, which then allows us to develop really multi-functional platforms."

Following initial work including process selection, systems engineering and sensor development, the Nuclear AMRC team started bead welding trials in June using a Polysoude narrow-groove welding torch. The team are now working towards full-depth welds before the end of the year.

The researchers are developing a variety of analytical and modelling techniques to allow full automation of the welding and inspection tool. These include a laser sensor which can be mounted on the weld head to measure weld geometry; electronic speckle pattern interferometry techniques to characterise the weld surface; and tools for acoustic analysis of the welding process.

"Defining data standards and communication protocols, and making sure everything physically fits on the tool, has been a challenge in itself," Smart notes. "The biggest technical challenge comes from the weld geometry – we've chosen a steep narrow groove, and the laser is having a lot of reflection issues inside the cavity."

The team 3D-printed a replica of the welding head to make sure that all the sensors could fit, without needing extra time on the welding cell itself. "We integrated everything on the replica then, when it came to the welding trials, we could just unbolt everything and reattach it to the real machine," Smart explains. Several of the individual sensor fixturings were produced by 3D printing.

Nuclear AMRC engineers are also developing new tools to predict weld bead geometries using an artificial neural network, and machine learning software to model the effects of multiple weld passes.

Other partners in the Simple consortium are meanwhile working on a variety of additional inspection and monitoring technologies.

The Advanced Forming Research Centre at the University of Strathclyde and Peak NDT are collaborating on an ultrasonic inspection system, with a prototype system now installed on a welding rig at Strathclyde.

Welding technology specialist TWI is developing a visual inspection system, and has recorded a series of videos of different

welding processes which will be used to train and test a neural network for real-time monitoring.

Physicists from the University of Sheffield are developing a process monitoring system which can be integrated with the Polysoude to record and analyse the welding parameters and optimise the process. The team have completed a series of test welds involving deliberately induced faults, and are now analysing the data.

Finally, integrated manufacturing specialists at the AMRC, the Nuclear AMRC's sister centre at the University of Sheffield, are drawing on technology used in the automotive industry for vehicle testing to manage the data from all the sensors in real time.

The Simple project started in January 2018, with its first phase on track for completion in August 2019. If it demonstrates the feasibility and value of integrating a range of technologies into a single automated tool, the consortium aims to secure further funding to support the development and commercialisation of a fully-integrated demonstration model.

"We've got lots of ideas for ways to develop this application," Smart says. "There's a lot of potential to transfer these technologies across to other processes like additive manufacturing and machining, and to integrate other inspection processes which is the whole goal of the Simple platform."

Simple is supported by £1.35 million funding from the Department for Business, Energy & Industry Strategy through the Small Business Research Initiative managed by Innovate UK, and forms part of the wider Nuclear Innovation Programme alongside the Inform project (see below) and other industry-led collaborations.

The project is supported by a range of nuclear industry partners – including reactor developers and operators, and decommissioning site owners – who will ensure the research is addressing industry challenges. The results will be shared with UK industry, including the Fit For Nuclear network of companies from along the supply chain.

Additive aid: research associate Dr Iwona Zwierzak sets up the sensor fixturing on a 3D-printed replica of the Polysoude weld head.

Results will also be presented at the next meeting of the Nnuman community (*see p8*).

namrc.co.uk/services/crd/simple

Informed approach to **pressure vessel production**

The Inform project aims to develop a range of advanced techniques which could halve the cost and time of manufacturing large complex nuclear components.

The Nuclear AMRC is leading the Inform project (Intelligent Fixtures for Optimised and Radical Manufacture), working alongside industrial and research partners. The collaboration is developing an adaptive fixturing system to ease the movement of large parts around a factory, and ensure precision through a range of innovative forging, machining, welding, inspection and assembly processes.

The proposed fixturing system will hold large components while they undergo the full range of manufacturing operations, and facilitate movement between tools. With sensors linked to actuators and manipulators, the fixture will automatically adjust its grip to minimise distortion during movement and manufacturing.

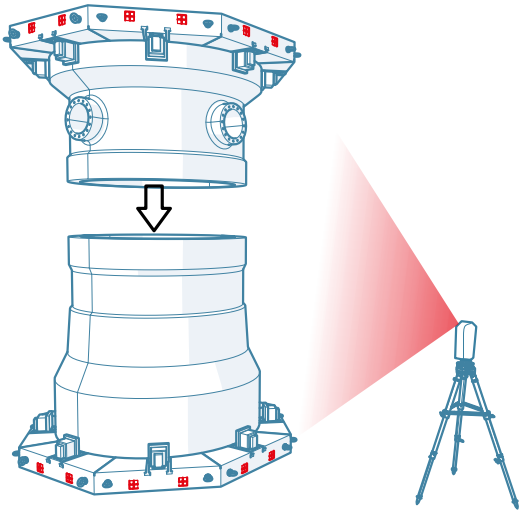
The consortium aims to demonstrate the fixturing system and allied technologies on large cylindrical parts representing a mid-range reactor pressure vessel. Current research focuses on proving the viability of these technologies at a small scale.

Project partner Sheffield Forgemasters is leading research into optimising the forging process for pressure vessel sections, from steel-making to machined condition of supply.

Nuclear AMRC researchers are investigating a variety of optimised machining and metrology techniques which could be applied to these forged sections. Machining techniques under development include near-net shape machining, advanced roughing algorithms, and supercritical CO_2 coolant to increase productivity in final machining.

MetLase, a joint venture between Rolls-Royce and Unipart, is meanwhile developing an intelligent fixturing demonstrator for assembling the vessel.

And welding research centre TWI is working with vacuum specialists Cambridge Vacuum Engineering, Specnow and EGB Vacuum to develop local vacuum electron beam welding technology, to join very thick vessel sections in a single pass without needing a vacuum chamber large enough to contain the entire assembly.



Integrating all the technologies into a single system will be a major challenges, and the project is drawing on the digital expertise of the AMRC's integrated manufacturing group to develop common data standards and software.

The current phase of the project is supported by around £1.1 million project funding from the Small Business Research Initiative, and will complete at the end of August 2019.

Ultimately, the integrated technologies developed by Inform could cut cost and time for manufacturing large complex nuclear components on a series of dedicated platforms by at least 50 per cent.

namrc.co.uk/services/crd/inform

Building bridges in the desert

The Nuclear AMRC supply chain team is working with partners in the United Arab Emirates to discuss how UK expertise can help support the new nuclear plant at Barakah. Project manager Anna Boland explains how the programme will benefit manufacturers in both countries.

The Nuclear AMRC is working with Emirates Nuclear Energy Corporation (Enec) to create a supply chain development programme in the UAE. This will support their nuclear programme at Barakah, where Enec is building four Kepco APR-1400 reactors, and is supported by the UK's Department for International Trade through the Nuclear Energy Innovation Development Centre initiative.

Both countries are currently nuclear technology importers, with domestic firms locked out of certain high-value markets and unable to to create new domestic capability or drive commercial growth. But both also have a strong appetite for R&D, a political commitment to nuclear, and close business links, offering the opportunity for a new partnership to help UK and UAE businesses work together at home and in other markets.

The project kicked off in July in the UK, with members of the Enec team visiting the Nuclear AMRC and four Fit For Nuclear (F4N) companies – CPE Pressure Vessels, Paul Fabrications, NIS and Endress+Hauser. The companies we visited were very hospitable and provided Enec with a good insight into the UK's manufacturing capabilities.

Our role at the Nuclear AMRC is to help UK companies win work in the nuclear industry. Part of that is to understand the international nuclear market, and match UK capability to commercial opportunities around the world.

Building relations between UK manufacturers and their counterparts in the UAE helps us to truly understand the gaps in capability for the UAE nuclear programme, and match those gaps to the UK supply chain's capabilities. Our initial project is piloting our successful F4N programme with six UAE companies.

In another part of the project, we will consider how best to establish other infrastructure that would further support the development of the UAE nuclear supply chain. This proposed study will consider areas specific to supply chain development, such as advanced nuclear manufacturing research, indigenous skill and capability development, manufacturing skills enhancement, apprentice training and supplier development.

Gulf power: head of supply chain Ian Williams, project manager Anna Boland, strategic advisor Chris Moore, and F4N industrial advisor John Olver visit the Barakah new build site.

As with all international partnerships, developing long-term trusting relationships is key. This was very evident in our latest visit. Our UAE hosts were very hospitable and clearly valued seeing familiar faces. I think we have helped to put the UK in the minds of the key decision-makers in the UAE nuclear programme, but this will need further nurturing to realise the opportunities.

As part of our engagement programme, the Nuclear AMRC team visited Abu Dhabi in September. As project manager of the supply chain development pilot programme for the UAE, I was fortunate to join the team and visit two units under construction at Barakah. It's clear that the plant is a matter of national pride to the Emirates. Seeing a plant in a part-built state gave me a better understanding of the sheer scale of the operation that is required to build these giant generators of energy, and has made me think twice about the efforts required to enable me to switch my lights on at night or charge my electric car.

We returned to Abu Dhabi in late October to proceed with the F4N pilot programme. Ian Williams, our head of supply chain, gave the UAE manufacturers a little more insight into what the F4N programme is about, and highlighted some key facts about the programme. And John Olver, one of our F4N industrial advisors in the UK, shared his experiences of helping companies through their F4N journey.

With the combined findings from the F4N pilot and the infrastructure study, we hope to develop international R&D projects involving manufacturers and researchers in both countries. That will benefit both UAE and UK supply chains as both nations embark on ambitious nuclear new build programmes and look to develop innovative products and services for export.

For more information about opportunities in the UAE, contact: **anna.boland@namrc.co.uk**

Faun Trackway gets Fit For Nuclear

Military precision: as an established defence supplier, Faun Trackway is used to fabricating to demanding standards.

Anglesey-based Faun Trackway is an established supplier to defence and other demanding sectors. Gareth Williams, engineering manager, explains how the company is preparing for opportunities in nuclear with help from F4N.

Faun Trackway Limited is an engineering and manufacturing firm based in Llangefni, North Wales. Previously known as Laird Anglesey, the company is fast approaching its ninth decade in operation.

Historically, our skills in design, fabrication, welding and painting converted to highly complex and bespoke projects that included bridges, torpedo boats, half-track Land Rovers, aviation, aerial masts and London buses.

Over time, these skills have translated into our signature Trackway product range, comprising portable roadways, expedient runways, helipads and marine access solutions, which continue to be used in military and civilian applications worldwide where the ground conditions are extremely poor.

Today, the growth and development of the brand has led to the formation of our three sectors – Trackway Defence, Trackway Access & Environment, and Trackway Engineering – with our Trackway Engineering team providing sub-contract engineering and design services for industrial and commercial use to an array of industries.

We have grown by focusing on specialised solutions for the most demanding markets, offering a service from design through to fabrication and testing.

As part of our strategic plan, we decided to diversify and target the energy industry, and specifically nuclear, following much research identifying opportunities.

Following discussions with the Welsh government, we decided to apply for F4N through their funding programme which is specifically applicable to Welsh SMEs like us.

We were delighted to have been chosen by the Welsh Government to pursue the F4N application. With the nuclear industry so vast an area, the team identified they had the capabilities on-site to tackle it but required the confidence and push to take the leap.

As a military supplier, we work to strict standards and focus on manufacturing excellence, and so the assessment identified many processes which were already in place. It is because of these processes that the assessment didn't highlight any major gaps in our operations.

The main area for development focused on 5S, alongside refining our existing procedures including a thorough recording of all meetings and providing evidence of improvements made, through the introduction of an IT communication platform.

We were delighted to complete the process in six months. During that time, we made the minor amends required, with the entire team playing a part in the F4N journey. The company purchased the necessary software to allow for enhanced project management through increased communication and recording of events and tasks.

Alongside this, we introduced and implemented a 5S culture into the workshop, allowing for enhanced efficiency and increased performance.

As a company freshly diversifying into the nuclear sector, the F4N process is already working for us as it has demonstrated the expectations of the industry and where we have come from to achieve those expectations.

We know tackling the nuclear industry is going to take a huge amount of resource to fully establish ourselves, but F4N gives us credence along with the confidence to present our capabilities.

We are now able to start formulating relationships, meeting with potential buyers and introducing our capabilities.

Acquiring F4N has given us the much needed platform to tackle the nuclear industry. Following the status approval, we can set our sights on marketing the brand, attending relevant exhibitions and networking events, and hopefully working in partnership with fellow F4N companies. Our procedures, systems, methods and culture are now geared to take the next step in our new chapter, and further support the future of British engineering.

fauntrackway.co.uk

F4N Fit For Nuclear

Is your company Fit For Nuclear?

Find out how you can assess your readiness and close any gaps with support from the Nuclear AMRC:

namrc.co.uk/services/f4n

Nuclear suppliers gather **for Birchwood showcase**

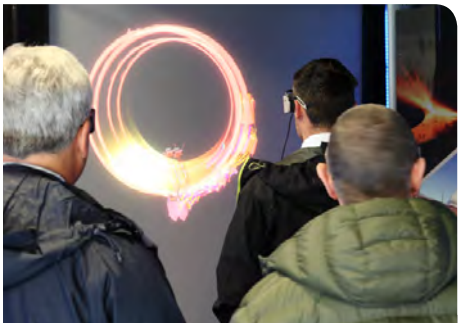
More than 500 nuclear professionals met at Birchwood Park, the heart of the North West nuclear cluster, in September to showcase engineering and technology solutions for the industry.

The UK's biggest independent nuclear suppliers' exhibition featured 75 exhibitors from along the nuclear supply chain, including many which have taken part in the Nuclear AMRC's Fit For Nuclear supply chain programme.

The day also provided more than 450 one-to-one meetings between suppliers and area specialists from Sellafield Ltd.

Several exhibitors offered live technology demonstrations, and the Nuclear AMRC's Mantra travelling showcase was on site to give a hands-on taste of the cutting edge of advanced manufacturing, with many of the visiting nuclear professionals testing their skills on the virtual welding kit.

The event was organised by Nu-Tech Exhibitions & Events, with support from the Nuclear AMRC, Nuclear Decommissioning Authority, Nuclear Institute, Nuclear Industry Association, National Skills Academy for Nuclear, North West Nuclear Forum and Birchwood Forum.



GFSA targets nuclear growth

Filtration specialist GFSA is targeting new opportunities in nuclear after being granted F4N status.

F4N
Fit For Nuclear

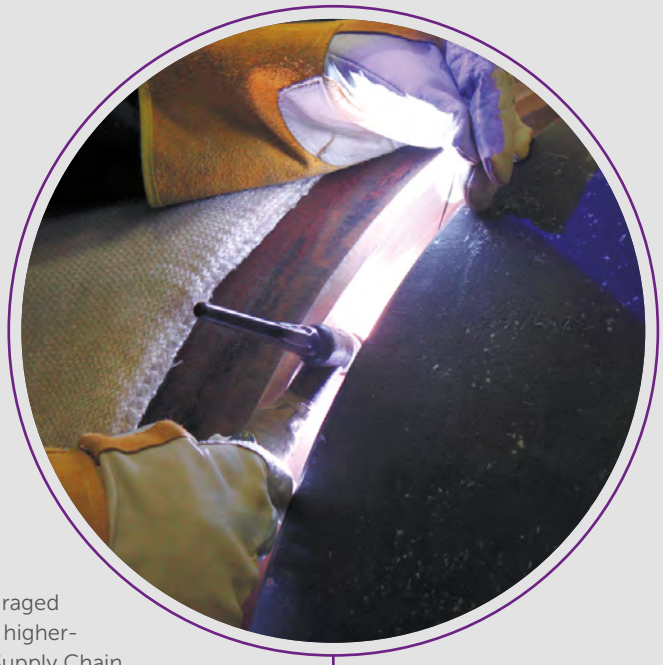
Based in Stourbridge, GFSA specialises in the design and manufacture of customised, high integrity filters, strainers and flame arresters in carbon steel, stainless steel, duplex, titanium and many other exotic alloys.

Since launching in 1997, the firm has become a leading supplier to the oil and gas, petrochemical, power generation, water and process industries worldwide. Managing director Simon Goddard entered the F4N programme to demonstrate that the business is also perfectly suited to supporting the nuclear industry as it embarks on a period of significant growth.

"Our core business sectors already include some of the most technically demanding and safety-conscious industries, such as oil & gas and petrochemicals, so we were confident that we would meet the Nuclear AMRC requirements," said Goddard. "It's an exciting time for our business as we seek to strengthen our position in the civil nuclear market."

www.gfsa.co.uk

South West manufacturers join for bids



Stronger together: the new alliance boasts more than 80 coded welders.

Six South West manufacturing companies have banded together to bid for larger nuclear contracts at Hinkley Point C and beyond.

The new South West Nuclear Fabrication Group (SWNFG) includes four Fit For Nuclear granted manufacturers – Arc Energy Resources, FLI Structures, Jordan Manufacturing, and Ledwood Mechanical Engineering – plus steel stockholder Bristol Steels and non-destructive testing specialist Technical Inspection Services.

"What we have established is a group of experienced engineering companies sharing an inherent nuclear safety and quality culture and with the capacity and capability to deliver highly-complex quality fabricated projects, de-risking the awarding of large volume and highly compliant work packages for tier one and two contractors at HPC," says Dave Cook, head of business development at Arc Energy.

Several of the companies have already worked at Hinkley Point C – FLI Structures was contracted to erect a communications tower, and Technical Inspection Services has worked on metal piles for the site's jetty.

The companies were encouraged to come together to bid for higher-tier tenders by the Hinkley Supply Chain Team, a collaboration between Somerset Chamber of Commerce, Business West and SWMAS with backing from EDF Energy.

"By liaising closely with the tier one contractors at HPC, we are ideally placed to uncover the kinds of work package opportunities that are appropriate for regional businesses to bid for," says Nik Brown, supply chain consultant at SWMAS. "What has been really rewarding is watching how all the member businesses of SWNFG have had the vision to see what can be achieved collaboratively and the commitment to make that happen.

"Not only do they meet regularly to identify the most effective way of working together, they have also taken the time to visit each other's premises and understand how their collective capabilities and resources best serve the market. What is all the more remarkable is the fact some of the group are competitors, yet they have put that to one side in order to present a united front when approaching the task of winning contracts at HPC."

Together, the SWNFG companies have a combined turnover of £74 million, 400 employees including 80 coded welders, and more than 11 acres of production fabrication space.

SWNFG: **www.nuclearfabricator.com**

Hinkley Supply Chain Team: **www.hinkleysupplychain.co.uk**

The Fit For Nuclear team are working with the Offshore Renewable Energy (ORE) Catapult to take the proven F4N model into the offshore wind sector.

F4OR
Fit For Offshore Renewables

Fit For Offshore Renewables (F4OR) aims to help the UK supply chain get ready to bid for work in the offshore renewable energy sector. It is based on the F4N supplier development programme, tailored to the specific need of the offshore wind industry.

A pilot programme, backed by the Scottish Government, will support 20 Scottish companies through the initial assessment stages and help them develop an action plan by the end of March 2019.

The ORE Catapult held launch events in Aberdeen, Edinburgh and Inverness in September to engage with suitable companies, supported by Scottish Enterprise and Highlands and Islands Enterprise, and featuring presentations from offshore developers EDF, EDPR and SSE to showcase the scale of the Scottish opportunity.

Following the pilot programme, F4OR could be rolled out across the UK.

ore.catapult.org.uk/stories/fit-4-offshore-renewables

Future H3AT: concept design for the new tritium research centre.

Opportunities for industry at new **fusion centres**

The UK's centre for fusion research is looking for nuclear-ready companies to help design, supply and commission two new technology centres.

The UK Atomic Energy Authority (UKAEA), based at Culham Science Centre in south Oxfordshire, plays a world-leading role in developing fusion power for electricity generation. UKAEA operates the world's largest fusion experiment, Jet, on behalf of European fusion researchers, and its own UK experiment, Mast Upgrade, which will explore fusion at reduced scale and cost.

The government is now investing £86 million to build and operate a new National Fusion Technology Platform (NFTP) at Culham. The funding was announced in December 2017, and forms part of the nuclear sector deal.

NFTP will comprise two new technology centres of excellence, expected to open in 2021.

The first centre, Hydrogen-3 Advanced Technology (H3AT), will research how to process and store tritium, one of the fuels that will power commercial fusion reactors.

The second, Fusion Technology Facilities (FTF), will carry out thermal, mechanical, hydraulic and electromagnetic tests on prototype components under the extreme conditions experienced inside fusion reactors.

Both centres will help UK industry secure around £1 billion in contracts from the international Iter fusion experiment. Currently under construction in the south of France, Iter is the stepping stone to full-scale commercial fusion power stations.

NFTP will also enhance the UK's expertise in critical areas of fusion research, with significant benefits to the economy as part of the government's industrial strategy. So far, 38 UK companies have won contracts totalling over €500 million on Iter.

The new centres will work closely with the industrial supply chain to create knowledge to position UK manufacturers for the next phase of Iter procurements in areas including the tritium plant, hot cell, measurement systems, assembly, maintenance and reactor materials.

Further ahead, NFTP will enable UKAEA to develop technology for the first fusion power plants, and put UK industry in a strong position to exploit the commercialisation of fusion.

UKAEA is already engaging with industry on the specification of the facilities. A series of procurement packages for design, supply and commissioning of plant and buildings will be issued through the OJEU process during the coming months.

UKAEA continues to develop its technology and research programmes to tackle the engineering challenges of fusion, and is working with a growing number of industrial and research partners. The new Remote Applications in Challenging Environments robotics centre is investigating remote maintenance systems for future fusion devices, while the Materials Research Facility tests the strength of candidate structural materials. Both work closely with industry and academia.

UKAEA is also leading the development of a new thermal hydraulic research and testing facility to be built in North Wales, supported by £40 million funding under the nuclear sector deal. The organisation is consulting with industrial, research and academic partners, and will submit detailed plans to BEIS and the Welsh government early next year.

For more information, contact NFTP director Colin Walters: **colin.walters@ukaea.uk**

Nuclear island: work is complete on the pre-stressing gallery, which sits beneath the reactor unit.

Reactor island takes shape at Hinkley Point

EDF Energy has confirmed that the 4,500 tonne concrete platform for the first new reactor at Hinkley Point C is on track for completion in 2019.

Work has now completed on the pre-stressing gallery for reactor one, which will sit below the reactor unit and help strengthen the main reactor building. Work on reactor two has also begun.

More than 3,200 people are working to build the new nuclear power station in Somerset, with £10.6 billion of contracts placed with suppliers. EDF says that 64 per cent of the project value is being built by UK firms.

"Everyone working on the project should be proud of what they have achieved so far," commented Stuart Crooks, Hinkley Point C managing director. "Unions, contractors and suppliers are successfully working together with a complete focus on quality and safety. Innovation and experience from other projects is helping us boost productivity and get ready for the next stages."

In September, four major UK contractors announced a new alliance to install mechanical, electrical and HVAC cabling and piping across the new power station. Altrad, Balfour Beatty Bailey, Cavendish Nuclear and Doosan Babcock will pool their expertise to work as a single entity, and will manufacture specialist pipework in the UK.

EDF meanwhile announced that it is aiming to start construction at Sizewell in Suffolk by the end of 2021.

"There is an optimal distance between the two projects which is about five years," EDF chief executive officer Simone Rossi told the Energy UK conference in October. "Hinkley Point construction started at the end of 2016 and so the best moment to start construction at Sizewell C is at the end of 2021. The further we wait, the lower the construction benefits will be because the supply chain may not be the same and skills could be forgotten."

Rossi emphasised that Sizewell C could be built at significantly lower cost by drawing on lessons learned from Hinkley Point.

"We have a great opportunity at Sizewell C to build a replica which would allow us to reduce the design costs," he said. "It would also reduce the development costs and we would profit from a skilled and experienced supply chain as well as lower qualification costs and paper work. All of that means a reduction in construction costs of about 20 per cent which will eventually flow through to consumers."

The third and final round of public consultation on Sizewell C begins in January 2019.

www.edfenergy.com/energy/nuclear-new-build-projects

Bechtel to lead **Wylfa Newydd project**

Horizon Nuclear Power has appointed global construction group Bechtel as project management contractor for its proposed Wylfa Newydd power station on Anglesey.

Horizon is planning to build two Hitachi advanced boiling water reactors (ABWRs) at Wylfa, and aiming to generate electricity in the mid-2020s.

US-headquartered Bechtel will lead the contractual and commercial interface with suppliers on behalf of Horizon, and will have nearly 200 employees embedded within the company. Hitachi has used the same model to deliver four ABWRs in Japan on time and on budget.

Hitachi Nuclear Energy Europe will deliver the ABWRs and act as architect engineer. JGC New Energy UK, a subsidiary of the Japanese engineering and construction group JGC Corporation, will provide a range of services around the balance of plant.

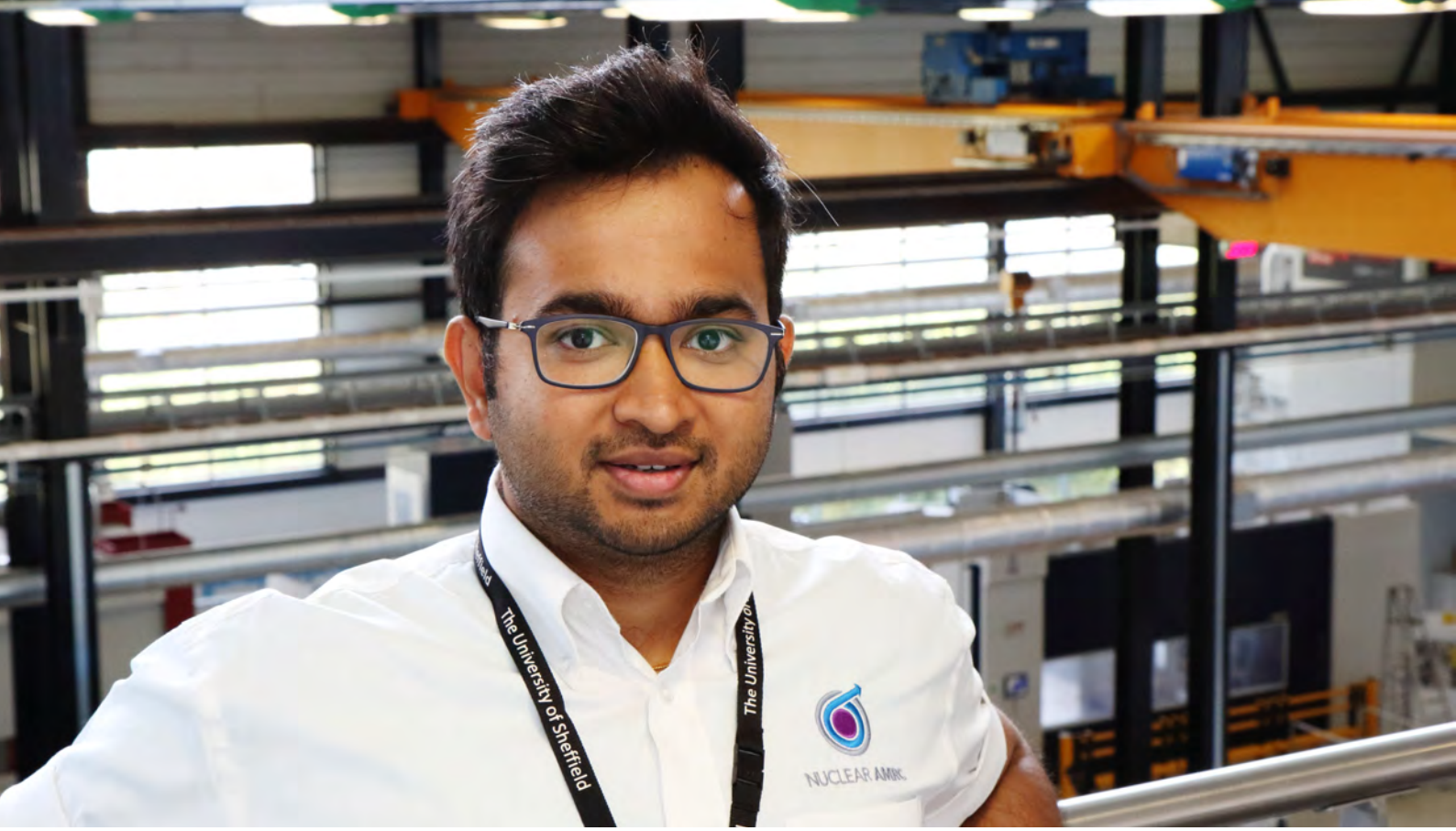
Horizon has also appointed three additional partners, each with significant UK employment.

Atkins, part of the SNC-Lavalin Group, will support on civil engineering design for the nuclear island. KBR will work on project controls, and Wood will support architect engineering.

www.horizonnuclearpower.com

NuGen, the developer of the Moorside site in Cumbria, has announced that its owner Toshiba is winding up the venture after failing to secure a buyer.

For updates, visit: **namrc.co.uk/intelligence**



Rahul champions the **science of baking**

Dr Rahul Mandal has returned to his day job after being crowned winner of ***The Great British Bake-Off***, and plans to use his success to help promote engineering to young people – and encourage more engineers to try their hand at baking.

Dr Mandal's baking skills became clear early in the hit series, broadcast on Channel 4 from August to October but filmed over the summer, and he quickly became a public favourite thanks to his innovative recipes and unassuming good nature.

His triumph is all the more remarkable because the research associate started baking cakes for colleagues at the Nuclear AMRC only two years ago.

Born in India, Mandal came to the UK in 2010 on a scholarship to study for his PhD in optical metrology at Loughborough University. He joined the Nuclear AMRC in 2015, to develop innovative automated techniques for inspecting components for any contamination or flaw. "It's all about measuring things with light," he says.

Mandal has been interested in cooking since childhood, but had never tried baking before coming to the UK – and only started in earnest after moving to Rotherham.

"I baked my first cake in 2016, and brought it into work for my birthday," he recalls. "Pretty much all my cakes have been brought into work. I wasn't ever really exposed to English baking before, so feedback from colleagues has been really important. From my first cake two years ago to what I do now has been a very steep learning curve."

One of those colleagues, commercial programme manager David Anson, also won fans after the programme revealed how he had taken Rahul under his wing after starting work at the Nuclear AMRC on the same day.

"Rahul only ever wants to know what's gone wrong with something, and there's a parallel there to his work in engineering," Anson says. "Research isn't about what's right, it's about what's wrong and how we can improve it."

Dr Mandal now works with a variety of light-based measurement technologies including confocal microscopy and interferometry for weld inspection, to ensure that components produced with innovative manufacturing techniques meet stringent quality requirements.

Like several of his Nuclear AMRC colleagues, he is also a volunteer Stem Ambassador, regularly working with young people to encourage them to study science, technology, engineering and maths-based subjects and develop related careers.

"If you can do baking, you can do science and engineering," he says. "And if you're doing engineering, then you can bake.

"I always like to talk about chocolate tempering – when you temper chocolate, it's a lot like what you do when your temper stainless steel. The principle is the same, and it has science behind it. Physics, chemistry and engineering is what baking is made up of."

Marathon challenge of **gender bias**

The nuclear sector deal sets challenging targets for female participation in the workforce, but an expert in gender bias has warned that tackling the problems will take years.

Currently, just 22 per cent of the nuclear workforce are female, and 15 per cent of nuclear engineers. The sector deal sets a target of 40 per cent women working across the nuclear sector by 2030, with half of all nuclear apprenticeships to go to women by 2021.

Professor Paul Walton of the University of York visited the AMRC Knowledge Transfer Centre in October to speak to researchers and managers from across the AMRC campus, and share his experience of tackling unconscious bias and overcoming obstacles to equality.

The progression of women in most scientific organisations is significantly hindered compared with men, Walton explained, leading to a loss of talent.

Diversity has a measurable impact on performance, he emphasised: "All the equality work we've done – including gender, race, age and disability equality – has been met at every stage by an increase in quality."

The business world has been quicker to realise the benefits of tackling inequality, Walton noted. "The world outside universities is rapidly dealing with this problem," he said. "Companies and charities are dealing with this with an energy that we are not. The bottom line of business really needs them to solve this problem."

Walton's own department of chemistry at York was the first in the UK to obtain the Athena Swan gold award in 2007, which recognises commitment to tackling gender inequality in higher education. The Nuclear AMRC was granted the Athena Swan bronze award in 2016 and is working towards silver.

The Nuclear AMRC is also a member of the industry-led Wise campaign for gender balance in science, technology and engineering, and is active in the Nuclear Institute's Women in Nuclear programme.

"You cannot whistle up equality overnight," Walton concluded. "It takes a long time – 10 to 15 years is possible. It is a marathon and not a sprint."

www.wisecampaign.org.uk

www.nuclearinst.com/women-in-nuclear

Diary

namrc.co.uk/news/events

Some of the events that the Nuclear AMRC will be attending or supporting in the coming months – **see us to find out more about how we can help your business.**

Nuclear 2018
6 December, London

Now in its 18th year, the UK's leading annual nuclear industry conference brings together speakers from across all parts of the nuclear industry to update and discuss key developments in 2018 and look ahead to 2019.

nuclear2018.co.uk

Nuclear AMRC Derby launch
13 February 2019, Derby

The Nuclear AMRC's new R&D centre opens its doors with a cross-sector industry event. The centre is developing two workshops in the iHub facility on Derby's Infinity Park to develop new technical capabilities and to help Midlands manufacturers innovate and win work.

For the latest information, email **events@namrc.co.uk**

TotalDecom supply chain networking
20 November, Rotherham

The Nuclear AMRC is teaming up with TotalDecom to offer the perfect platform for manufacturers to network with supply chains which seek their skills and expertise. The event includes updates from Sellafield and Babcock, plus one-to-one meetings with the top tier.

www.decomhub.com/conferences-events/supply-chain-networking-event-namrc

MetMap
22–23 January 2019, Rotherham

The first of two conferences being held as part of a roadmapping project to define the future of integrated metrology in advanced manufacturing in the UK. MetMap is organised by the University of Nottingham, and hosted at the AMRC Knowledge Transfer Centre.

www.nottingham.ac.uk/conference/fac-eng/metmap-2019

DIT Civil Nuclear Showcase
26–27 February 2019, London

A unique opportunity to network with senior industry delegates from key global markets including China, France, Japan and the US. The two-day conference also includes speakers from the UK and around the world, and break-out sessions on export and collaboration opportunities.

For details, email: **DITNuclear@brayleino.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 your business, contact Jay Shaw, Nuclear AMRC programme director:
jay.shaw@namrc.co.uk

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