NUCLEAR AMRC news
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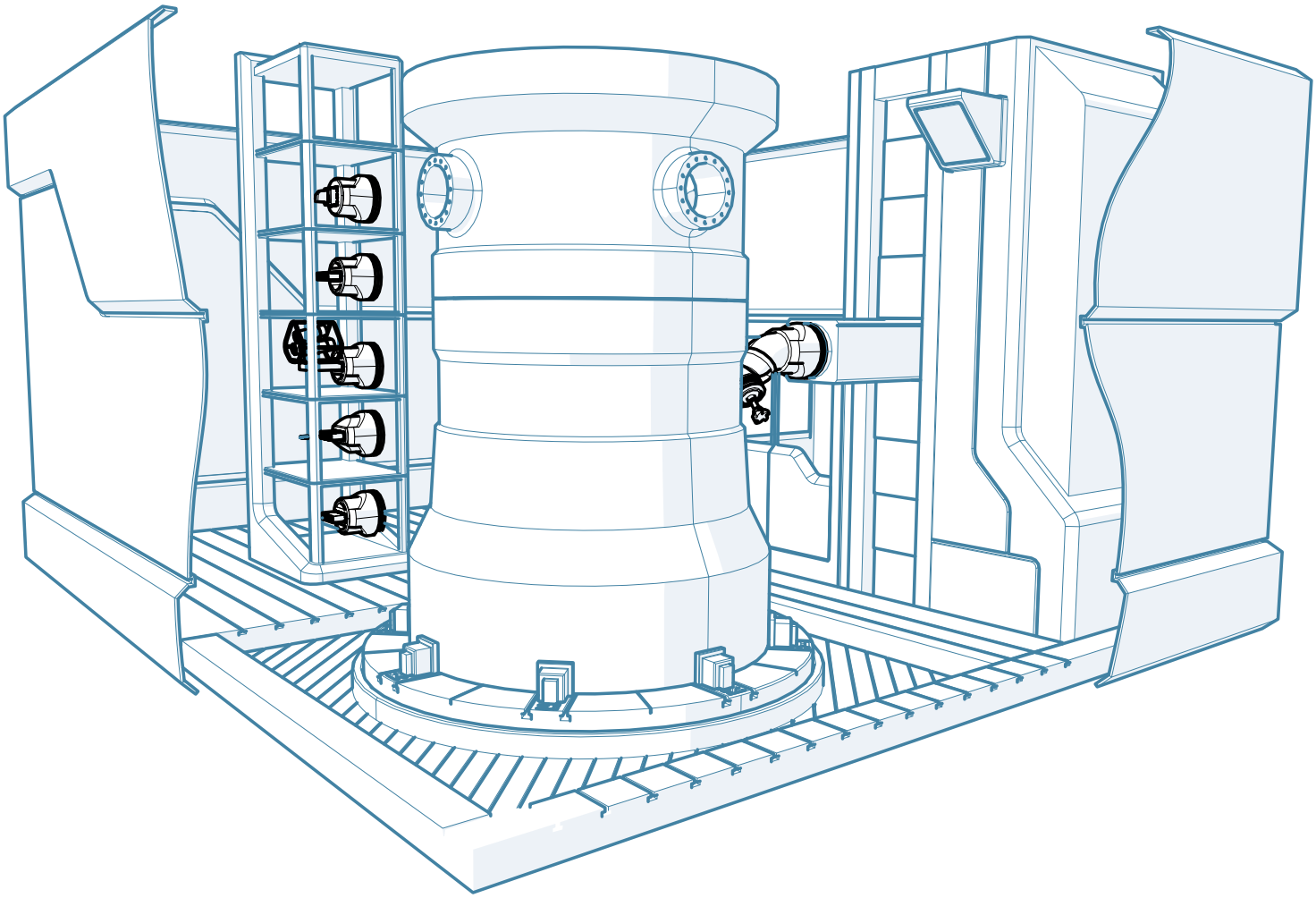
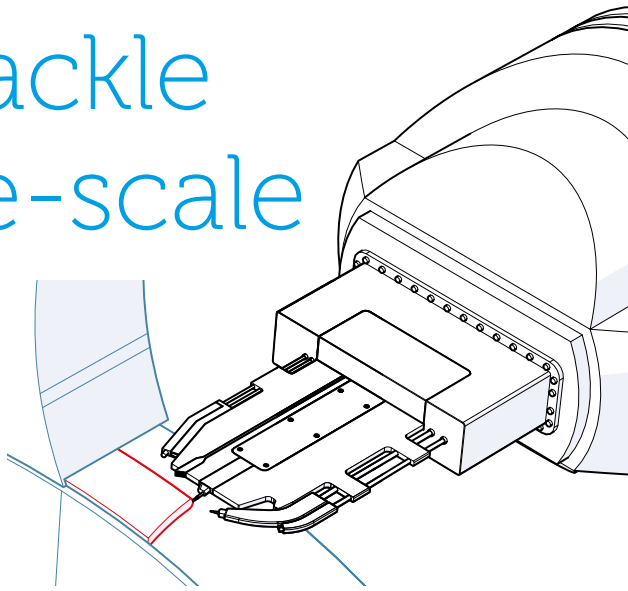


Large-scale manufacturing made simple

New research collaborations aim to halve production cost and time for large nuclear components

CATAPULT
High Value Manufacturing

New projects tackle challenges of large-scale manufacturing



The Nuclear AMRC is leading two new R&D projects to address fundamental challenges in nuclear manufacturing.

The Inform and Simple projects, backed by government funding of almost £2.5 million, will investigate two contrasting approaches to producing large-scale nuclear components.

"It's the two different philosophies of manufacturing large high-value components – taking the part to the machine, or taking the machine to the part," says Nuclear AMRC programme manager David Anson.

The Inform project (intelligent fixtures for optimised and radical manufacture) will develop an adaptive fixturing system to ease the movement of large parts and ensure precision throughout forging, machining, welding, inspection and assembly.

"Inform is about taking the component to each of the machines in turn, because dedicated machines have much better capabilities, rigidity and accuracy," Anson notes. "The problem is that when you move large heavy items around the factory, you lose a lot of manufacturing time. This is much more significant in nuclear than it is in sectors like aerospace and automotive."

The project will develop a through-life fixture which can hold large components while they undergo a range of 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. It will also allow large components to be aligned and assembled more efficiently.

The fixturing technology will be demonstrated on large cylindrical parts representing a two-thirds scale replica of a mid-range reactor pressure vessel. These parts could also represent large nuclear parts such as heat exchanger, steam generator and valve casings, as well as assemblies for other sectors such as offshore wind turbine tower sections.

The Nuclear AMRC is leading the project, backed by around £1.1 million project funding, with partners include fixturing specialist MetLase, Sheffield Forgemasters, Cambridge Vacuum Engineering, NPL and TWI.

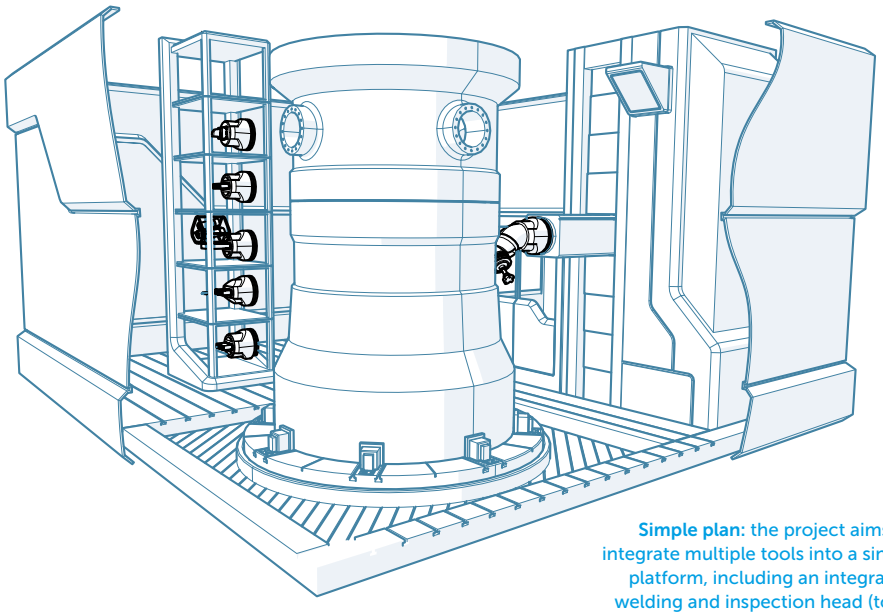
The funding will support collaborative R&D over 20 months, and follows an initial three-month feasibility study by the Nuclear AMRC. If the research proves fruitful, the project could be extended for a second phase of around three years to commercialise the technology.

The consortium will also investigate complementary advanced manufacturing techniques which could be integrated with the Inform fixturing system in the second phase. These include hollow-ingot forging techniques to produce near-net shape forgings which need less machining; and local-vacuum electron beam welding techniques to join thick sections in a single weld without needing a large vacuum chamber.

Ultimately, the project aims to cut cost and time for manufacturing large complex nuclear components on a series of dedicated platforms by at least 50 per cent.

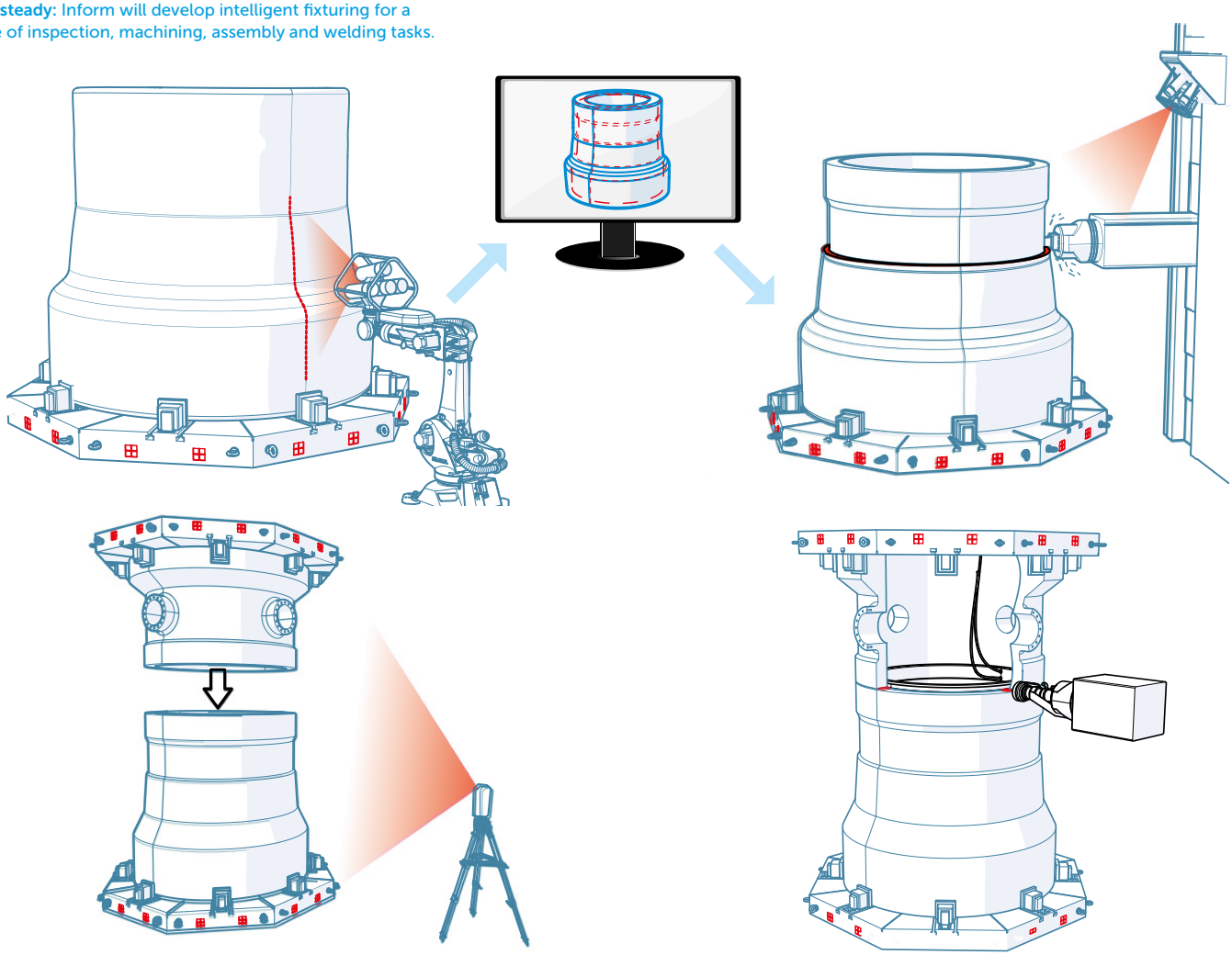
Moving more efficiently between platforms isn't the only answer to the challenges of large-scale manufacturing, however.

"The other philosophy is to look at a single platform approach which brings additive manufacturing techniques onto the same



Simple plan: the project aims to integrate multiple tools into a single platform, including an integrated welding and inspection head (top).

Hold steady: Inform will develop intelligent fixturing for a range of inspection, machining, assembly and welding tasks.



platform as subtractive machining, so you can do a lot more things on one component in one place," Anson says. "You can also bring in on-machine inspection to avoid having to take large components away to a CMM – if you do welding there as well, you can make sure there's no distortion while it's still on the machine. It's all about combining more things on one platform."

The second project, Simple (single manufacturing platform environment), takes this approach. Supported by £1.35 million project funding, the Nuclear AMRC will lead a research consortium including two of its sister centres within the High Value Manufacturing Catapult, the Advanced Forming Research Centre and AMRC with Boeing, as well as the University of Sheffield physics department, TWI and Peak NDT.

In the first phase of Simple, the partners will develop an integrated welding and monitoring system which combines a range of sensors and testing tools with an automated arc welding head. This will allow automated in-process inspection of welds, improving quality and reducing the risk of weld failure leading to costly scrapping or rework.

As with Inform, the current project could lead to a second phase, in which the Nuclear AMRC will build a production-scale demonstrator of the integrated welding head and test it on one of the centre's largest machining platforms.

Further development could then integrate this tool with a comprehensive selection of machining, cladding and inspection heads on a single manufacturing platform. By combining conventional and advanced techniques onto a single platform, the project aims to achieve cost and time savings of at least 50 per cent for a range of complex fabrications.

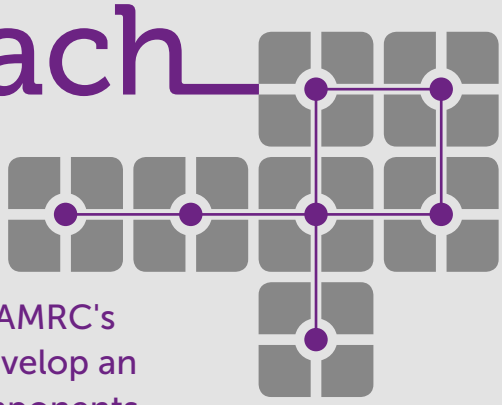
Simple will focus on large components measuring at least two metres such as pressure vessel sections, large valve casings and decommissioning waste containers. The technology could also be used to reduce risk of manufacturing error and cut cost and time for smaller high-value components for the nuclear island, and deployed in other sectors such as energy, oil and gas, marine and aerospace.

The Simple and Inform projects are funded by the Department for Business, Energy & Industry Strategy (BEIS) through the Small Business Research Initiative (SBRI) managed by Innovate UK.

Both projects are 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.

Either of the two approaches may prove more beneficial for different components, Anson notes, and elements from both projects could be combined for specific applications. "There's always a trade-off because the actual processes used on a single platform may not be as efficient as a dedicated machine," he says. "There's a balance to be struck, and both approaches have their place."

Modular approach to testing rigs



Work is starting on the first major project at the Nuclear AMRC's new modularisation research facility in Birkenhead, to develop an innovative modular testing rig for a range of nuclear components.

Nuclear AMRC is working with Frazer-Nash Consultancy to develop a new design concept for a thermal hydraulic rig.

A thermal hydraulic rig is a large engineered assembly used to test and study the behaviour of components and sub-assemblies under a variety of operating conditions, including extremes of pressure and temperature, to simulate conditions experienced in nuclear reactor systems.

"These rigs are used to test various components, sub-assemblies and modules for different thermal gradients – with extremes of hot and cold – at different pressures and, in some instances, different coolant fluids," says Steve Lawler, Nuclear AMRC operations director, who is leading the project. "They exist in current facilities, but what we'd like to do is create a single facility that can cater for any component or module for any reactor power plant, all in one place. It'd be like having a complete test facility in one building. The key to that is making it modular."

As part of a project for the Department for Business, Energy and Industrial Strategy (BEIS), Frazer-Nash is developing a specification for a new national thermal hydraulics test rig to underpin the development, safety and efficiency of the next generation of nuclear reactor designs.

The parallel project with the Nuclear AMRC, funded by Innovate UK through the High Value Manufacturing Catapult, offers what Lawler calls the perfect opportunity to apply the principles of modularisation to a demanding nuclear engineering project.

"No one has been able to apply modularisation at this stage of development, to something that's not even designed yet," he says. "You usually have a bespoke rig for a particular reactor and particular component type, but we want to get away from that. We are aiming to develop a rig that can test any component or assembly you can think of in a nuclear power plant, under any conditions."

Modular build can provide real benefits to the project, says Caroline Longman, business manager at Frazer-Nash. "Modularisation provides the ability to reduce on-site commissioning costs and timescales by pre-assembling and testing sub-assemblies prior to transportation," she says. "It can also provide the opportunity to reconfigure on-site by substituting modules rather than at component level."

A comprehensive modular rig will help satisfy the UK's requirements for equipment qualification (EQ), a systematic approach to ensuring that safety-critical components and systems being manufactured for new nuclear power stations meet the relevant quality standards. The Nuclear AMRC is working with an alliance of nuclear engineering companies to examine the EQ challenges facing the UK's nuclear new build programme, with a first report due before the end of the year.

As well as meeting new build requirements, the final modular rig may also be able to inspect safety-critical components throughout their life to meet the safety requirements of operating nuclear plant. "The ultimate goal is to have a rig that can be used for post-irradiated inspection – for example, a coolant pump that's gone through 40 years of life in a reactor," Lawler says. "One of the big challenges is: can we have a module that contains the component and allows inspection?"

The initial project will develop a virtual model of the rig, using the Nuclear AMRC's VR and digital modelling capabilities to prove the concept of a modular rig.

The Nuclear AMRC team then propose to use 3D printing to produce prototype components for the rig, to show how the modules can fit together to meet different requirements.

The project will also draw on the expertise of partners including Cammell Laird, a tier one member of the Nuclear AMRC with a wealth of experience in applying modularisation principles to maritime engineering. The Nuclear AMRC's modules facility, which opened in July, is based alongside Cammell Laird's 120-acre site in Birkenhead.

Miguel takes lead in modular manufacturing

Experienced research engineer Miguel Garcia has been appointed as the Nuclear AMRC's technical lead for modular manufacturing.

Garcia has worked at the Nuclear AMRC since 2012, and was previously a senior research engineer focusing on the optimisation of manufacturing and machining processes. He also helped deliver a variety of industrial R&D projects as part of the Civil Nuclear Sharing in Growth programme.

He will now lead the development of industry-focused R&D at the Nuclear AMRC's new Birkenhead research facility. With over 1,000m^2 of workshop space, the Birkenhead facility will host specialised machining, joining and assembly equipment to develop and prove modular manufacturing techniques for nuclear applications. "Our aim is to become the UK centre of excellence for modularisation, and help the UK supply chain improve its competitiveness and win work in the nuclear industry," Garcia says.

Cooling breakthrough: first trials drilled through 60mm of titanium alloy.

Supercritical benefits for deep hole drilling

Nuclear AMRC machining engineers have completed the first cutting trials using a new supercritical carbon dioxide coolant system.

The innovative system has been fitted on the large Starrag HEC1800 horizontal boring machine, and delivers supercritical CO_2 at pressures of over 100 bar.

A supercritical fluid combines the physical properties of both a liquid and a gas. Many substances can become supercritical at a sufficiently high temperature and pressure – for CO_2, supercritical conditions are above 74 bar and 31°C.

"A supercritical fluid doesn't have distinct gas and liquid phases," says Dr Krystian Wika, Nuclear AMRC technology lead for advanced coolants. "The advantage for machining is that the coolant has the density of a liquid, so it can carry out the swarf from really deep holes, but it also behaves like a gas."

The supercritical CO_2 technology was developed at the University of Michigan and is exclusively licenced to Fusion Coolant Systems, which is supplying the Nuclear AMRC's new equipment. The technology has been shown to increase cutting speeds and reduce tool wear, compared to traditional oil-based coolants and minimum quantity lubricant (MQL) techniques.

For the nuclear sector, supercritical CO_2 can potentially be used for deep-hole drilling operations which are essential for components such as heat exchanger tube plates.

Wika's team will initially focus on small diameter drilling, where the wear mechanism of the tool edge and effects on the workpiece's material properties are not well understood for supercritical CO_2. During initial trials, the coolant will be delivered through the spindle at a pressure of around 120 bar and temperature of 34°C. Further research will then optimise the parameters for specific applications.

Deploying the Fusion system on the large Starrag platform will also let the team develop CO_2 cooling techniques for large component turning. This can avoid problems which occur when liquid coolants collect within a large part and affect its centre of mass.

The HEC 1800 is now equipped with a choice of coolant options including high pressure fluid and supercritical CO_2 with or without MQL. Supercritical CO_2 is an excellent solvent, Wika notes, which allows a perfect mix of MQL and CO_2 for the most demanding applications.

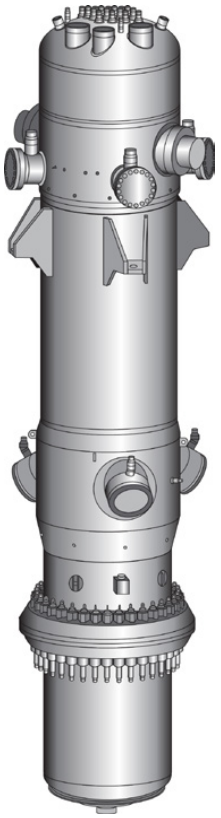
Supercritical CO_2 coolant is different to the near-cryogenic coolants which Wika's team have previously investigated (*Nuclear AMRC News 26*). Cryogenic research at the centre has focused on the ChilAire technology, which delivers a controlled stream of carbon dioxide gas and CO_2 ice particles at temperatures as low as –78°C. The team are now investigating how that technology can be made more flexible so that it can be easily deployed on any machining platform.

fusioncoolant.com

Fusion power: the system delivers CO_2 at pressures of over 120 bar.

US collaboration to **revolutionise pressure vessel production**

The Nuclear AMRC is starting work on a four-year collaboration with the US Electric Power Research Institute (EPRI) to develop new manufacturing and fabrication methods for reactor pressure vessels.



Power Module: the project will focus on the upper and lower assemblies of NuScale Power's reactor pressure vessel.

The collaboration aims to develop a variety of advanced manufacturing techniques to reduce the total time needed to produce a small modular reactor (SMR) pressure vessel to less than 12 months.

Currently, pressure vessels are produced as large forged low-alloy steel components. For the current generation of gigawatt-scale reactors, producing the main pressure vessel can take up to five years. Only a few forges worldwide have the capabilities to produce the largest forgings, which can create a serious bottleneck for nuclear new build programmes.

The EPRI project, funded by the US Department of Energy, will develop an array of technologies which will allow reactor pressure vessels to be made from smaller component sections while eliminating the risks and constraints of current welding practices.

The Nuclear AMRC will help prove these technologies on two-thirds scale prototype components for the 50MW Power Module SMR being developed by Oregon-based NuScale Power. NuScale has worked with the Nuclear AMRC since 2014 on technology collaboration and UK supply chain support.

The project will include development of ASME Code Cases for these manufacturing and fabrication technologies, allowing them to be used in variety of advanced reactors and other plant applications.

"It is anticipated that these technologies will be applicable to advanced light water reactors, Generation IV nuclear reactors, ultra-supercritical fossil units, and advanced CO_2 supercritical plants," says EPRI technical executive David Gandy. "Some of the technologies are already being used at small scale in punishing environments such as aircraft engines and offshore oil and gas rigs at the bottom of the North Sea."

The project aims to produce vessel sections from metal powder using hot isostatic pressing (HIP), and join them by electron beam welding.

Earlier work by EPRI and others has shown that powder metallurgy HIP can be used with multiple alloys to produce near-net shape components with a homogeneous microstructure which are suitable for reactor vessels. "These require minimal machining to achieve the final geometry of complex parts, and homogeneity means a vastly easier inspection process and good properties," Gandy notes.

Electron beam welding can join thick sections of alloy in a single weld with no need for filler material. This significantly reduces the need for inspection during manufacture, and could eliminate the need for in-service inspection. The Nuclear AMRC will use its Pro-Beam K2000 electron beam welding cell, believed to be the largest available for collaborative research anywhere in the world, to join vessel sections produced by HIP processes in the US.

EPRI estimates that the two technologies together can reduce welding time for an SMR pressure vessel by 70 per cent, overall production time by 60 per cent, and manufacturing costs by as much as 40 per cent.

The Nuclear AMRC will also apply a range of other advanced manufacturing technologies which can improve efficiency in vessel production. These include diode laser cladding, which uses a fully automated system to deposit a thin layer of corrosion-resistant alloy to the interior of the vessel and nozzles. This technology can clad large areas in a fraction of the time taken by manual cladding processes, while reducing the amount of cladding material required by up to 75 per cent,.

Following a series of initial projects to prove the viability of the processes and determine initial parameters, the Nuclear AMRC is now leading the fabrication of critical SMR assemblies.

The first phase focuses on the lower assembly of NuScale's reactor pressure vessel. This includes a lower head made of two large sections produced by HIP, a forged flange shell, and transition shell with four HIP sections and a forged flange.

The second phase will then focus on the more complex upper assembly, which includes an upper head with 27 nozzle penetrations.

The project involves industrial partners on both sides of the Atlantic. Sheffield Forgemasters, a tier one member of the Nuclear AMRC, will produce a series of forgings for the vessel assemblies and help develop localised heat treatment methods. Synertech-PM in Los Angeles will produce the HIP components from metal powders provided by Pennsylvania-based Carpenter Powder Products.

EPRI is an independent, non-profit organisation for public interest energy and environmental research, focusing on electricity generation, delivery and use. It operates from six facilities across the US.

www.epri.com

Tackling the **EQ gap**

The Nuclear AMRC is tackling a national gap in equipment qualification (EQ) capabilities, with experienced engineer Chris Jenkinson joining the centre as EQ technical lead.

EQ is a systematic approach to ensuring that safety-critical components and systems being manufactured for new nuclear power stations meet the relevant quality standards. It is intrinsically linked to nuclear safety, and UK manufacturers bidding for new build work will need to understand if there are EQ requirements for their particular products and, if so, how they can be satisfied.

"The UK's EQ capability gap is broadly recognised as a barrier to UK manufacturers entering the nuclear supply chain, since they face tough competition from established international competitors with a nuclear pedigree," says Jenkinson. "Delivering an effective strategy that closes the EQ capability gap will create parity for UK manufacturers that will be a key enabler for them to competitively bid for and secure nuclear work."

Earlier this year, the Nuclear AMRC commissioned the EQ Alliance – comprising Rolls-Royce, Lloyd's Register, Assystem and Arexis – to produce a detailed report on EQ requirements for the UK new build programme, and examine the UK's current capabilities. The Alliance's initial report will now be shared with stakeholders, and Jenkinson is developing an EQ strategy for the centre based on its findings.

"EQ is a cross-disciplinary subject which spans multiple areas within the Nuclear AMRC's complementary manufacturing research and business development scope," Jenkinson notes. He will work closely with the Nuclear AMRC's supply chain development team to raise manufacturers' EQ competence, and with the centre's technical teams to establish which current and future manufacturing innovations may need to consider EQ.

Jenkinson joins from Rolls-Royce, where he held technical, project and leadership roles in the aerospace and nuclear sectors over 12 years.

"I was privileged to be involved in the development of safety-critical and safety-related systems at different life-cycle phases for highly-regulated aeroengine and nuclear reactor applications, for which EQ was a fundamental consideration," he says. "I can now apply this experience, and the academic study I have undertaken and applied, to objectively resolve the challenges of EQ for the nuclear supply chain."

namrc.co.uk/services/eq

Laser cell takes shape

The Nuclear AMRC's powerful new laser cell is now taking shape, ready to start developing innovative welding processes in the new year.

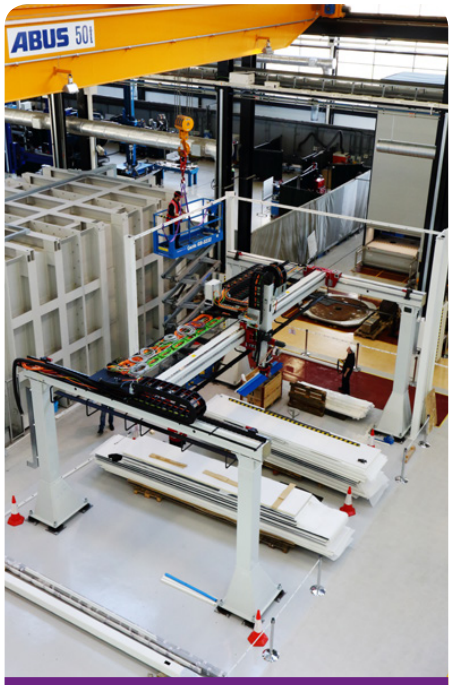
The 16kW disk laser is believed to be the most powerful of its kind in the UK. The cell is designed to produce high-quality deep penetration joins, from around 15mm in stainless steel.

It will also be capable of delivering a simultaneous MIG weld for hybrid welding, and will be used to investigate laser cutting techniques for decommissioning.

The laser 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.

The cell is designed and built by Loughborough-based Cyan Tec Systems, a specialist in integrating robotic and laser systems for industrial applications.

namrc.co.uk/capabilities/innovation/welding



Laser power: the gantry-mounted laser (above) will sit within a safety enclosure (left).

Demand model to match nuclear manufacturers with work

The Nuclear AMRC and Nuclear Industry Association (NIA) are working together to map future contract opportunities in the nuclear market, and help match manufacturers with relevant work packages.

The Nuclear AMRC has secured funding from Innovate UK, through HVM Catapult, to create a robust model of future demand for UK nuclear manufacturing. The model will help manufacturers identify work packages which they can bid for, and allow R&D and support to be focused on areas of the greatest value to the UK supply chain.

The demand model will build on work carried out by NIA industrial advisors Glen Little and Chris Savage over the past year to create an initial database of future contract opportunities across the nuclear sector, including new build, decommissioning and naval.

"Our work to build a picture of the demand profile for new nuclear plants and detailed work packages was a necessary first step to understanding what future opportunities will look like for the UK's supply chain," says Savage.

"The next stage will be to match these against the capabilities of UK companies, so we can identify where the opportunities are for the UK and to design targeted interventions where required."

The initial project will focus on particular commodity requirements for a representative new build project. The modelling methodology can then be extended to cover the full range of commodities and components for the new build programme, as well as the requirements of the decommissioning and submarine programmes.

"The demand model will give us visibility of the supply chain opportunities for the next 20 to 30 years, which will allow us to match the best suppliers to those opportunities," says Helen Arthur, supply chain development programme manager at the Nuclear AMRC. "It will provide a long-term view of the schedule for the major nuclear programmes, and make sure that suppliers are ready to bid for work packages when they go out to tender."

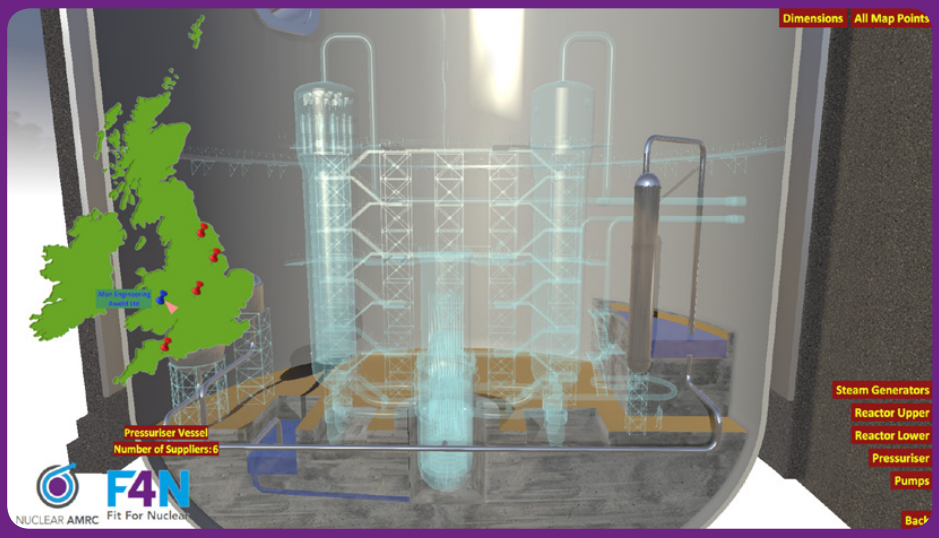
The work could also provide valuable information to inform government about where strategic interventions from Whitehall can help address capability gaps in the UK's nuclear supply chain.

The NIA has also joined the Nuclear AMRC as a tier one member. The two organisations will work closely together to share knowledge on the nuclear industry, focusing on demand modelling and other initiatives that will benefit the whole UK supply chain.

www.niauk.org

Virtual demand modelling

The Nuclear AMRC's visualisation specialists are combining demand model data with a virtual model of a complete reactor system, to create an interactive and intuitive tool for supply chain development.



The prototype system (pictured) combines a generic reactor design with historic market information about which UK manufacturers have the capabilities to produce each component. The detailed 3D virtual model allows the reactor to be broken down into its sections, components and commodity types, and identifies suppliers capable of producing each system.

Research engineer Craig Hamer says the vision is to integrate the visualisation tool with real reactor designs, live data of supply chain capability and capacity, and the demand model data being developed in collaboration with the NIA. That will give developers, suppliers and other stakeholders an intuitive, interactive tool for understanding specifications, identifying potential supply chain partners, and showcasing domestic involvement in new build projects.

The prototype system has been demonstrated at industry events including a High Value Manufacturing Catapult reception at the House of Commons.

Executive **view**

A new deal for UK nuclear?

It doesn't seem long since the last edition of the newsletter, and here we are again. There is a lot going on across a range of topics that many of you, our members and wider stakeholders, are involved in and in many cases leading on.

In the last edition, I mentioned the areas of future focus that we plan on developing. I am pleased to say these are all progressing well against our plan. We also welcome a key member of the Nuclear AMRC team as Professor Steve Jones joins as our chief technology officer. We are really pleased to have a technical expert and someone who understands the nuclear market and research arena so well.

The market we serve continues to develop. EDF continues to make progress at Hinkley Point with the EPR, and is also giving much more attention to Sizewell C with Humphrey Cadoux-Hudson overseeing future new build developments while Stuart Crooks heads up delivery at Hinkley Point C.

Getting these huge projects off the ground continues to prove difficult, as we see at Moorside where NuGen is working closely with potential technology vendors and government to find an acceptable plan to move forwards.

The proposed nuclear sector deal was presented to the energy minister Richard Harrington at the recent Nuclear Industry Council. This was agreed by the Council and, following the release of the industrial strategy white paper in November, we are expecting further details to be announced shortly. UK new build, decommissioning and waste management will be big topics, as is the future technology plan covering small modular reactor (SMR) development in the UK. The SMR process launched by BEIS in March 2016 is now closed, and a new process is likely to be announced as part of the sector deal. This should provide much needed clarity for the supply chain around SMRs in the UK.

One of the biggest impacts of the Nuclear AMRC comes from our supply chain development work. We have two core programmes: Fit For Nuclear (F4N) and Civil Nuclear Sharing in Growth (CNSIG).

The four-year high-intensity CNSIG supplier development programme is now coming to an end. It has succeeded beyond all our expectations. The targets for new work won, jobs created and safeguarded, and new private sector investment were all exceeded barely halfway through the four-year programme. What great results and impact for the supply chain – as recognised at the NDA supply chain awards in November, where CNSIG won the award for best enhancement of capability and capacity.

These results don't come easily. They are a real testament to the dedication and hard work of the participating companies, at all levels from senior executives to shopfloor operatives. It's also testament to the CNSIG team of specialist advisors, trainers, engineers and project staff who have given their all to help the companies achieve their full potential.

Supply chain development programmes like CNSIG are fundamental enablers to a globally competitive nuclear industry in the UK. As this programme comes to an end, we're building on its success through our ongoing F4N programme. We recently enhanced F4N to provide additional targeted support to companies after achieving F4N granted status. We are continuing to apply the knowledge we've developed through CNSIG to develop new services and add more value to UK industry. And of course, we are linking our supply chain development work with our manufacturing innovation programme, to help more companies of all sizes raise quality, reduce costs, and develop new technical capabilities.

We are passionate about enhancing our supply chain development work and increasing our impact, and I hope to bring news on the future of this soon. I have talked to all manufacturing sectors about F4N and CNSIG and am pleased that our supply chain development is seen as best practice – we just need to keep it going.

By the time you read this, we will be nearing the festive season. I know the team at Nuclear AMRC deserve a well-earned break – 2017 has been not only busy but also difficult with some of the challenges we have faced and continue to deal with.

I'd like to take the opportunity to wish you all a great Christmas and here's to a very prosperous and healthy 2018.

Andrew Storer, chief executive officer, Nuclear AMRC.

Focusing on innovation: Professor Steve Jones appointed CTO

Renowned welding expert Professor Steve Jones has joined the Nuclear AMRC as its new chief technology officer (CTO).

As CTO, Professor Jones is responsible for the Nuclear AMRC's technology strategy, and making sure the centre meets the technical needs of the UK nuclear industry.

He will lead the development of a host of advanced processes – including large-scale intelligent machining, advanced arc and power beam welding, bulk additive manufacturing, and modularisation – for the nuclear sector, and explore nuclear applications for emerging technologies such as digital twinning and collaborative robotics.

He succeeds Stuart Dawson as CTO, who has moved to the same position at the Nuclear AMRC's sister centre, the AMRC with Boeing.

Nuclear AMRC News asked Professor Jones to introduce himself.

My manufacturing career began in 1980 as an apprentice welder within Rolls-Royce Motors in Shrewsbury, working on highly-finessed components for the automotive and aerospace divisions, and moving up to rather large fabrications and engine modules for the military and marine sectors.

My passion to fundamentally understand those complex welding sciences put me on a 17-year higher education journey with the Open University that culminated in achieving my doctorate in materials and welding engineering in 2003. Between 2003 and 2005, I was a post-doctoral researcher within the University of Nottingham, investigating the feasibility of applying the shaped metal deposition process to produce complex aerospace components from nickel-based alloy.

Between 2005 and 2015, I returned to Rolls-Royce as global engineering specialist for joining sciences, supporting the company's civil nuclear division in obtaining the coveted ASME N-stamp. I also started working with the Nuclear AMRC as visiting professor of welding engineering.

Most recently, I was professor of joining and advanced manufacturing systems at Coventry University's Advanced Manufacturing and Engineering Institute (AME), researching innovative solutions for the automotive, aerospace and nuclear sectors.

As a Chartered Engineer, Fellow of The Welding Institute, TWI Council member and chair of their professional board, my passion for the fabrication sciences is as high today as it was when I started my educational journey. Combining engineering practicality with long-term academic training allows me to describe myself as a "pracademic" – a word I am cautious about using in potentially tongue-tied situations, but a credential that I hope will add to the already highly proficient skills set at the Nuclear AMRC.

Horizon scanning: Steve Jones will explore new technology areas such as digital twinning for factories.

As chief technology officer, my role is to ensure that the Nuclear AMRC is focused on providing appropriate innovative solutions which UK manufacturers can use to become truly competitive players in the global market. This requires the development of a robust technology strategy that necessitates a global visibility of technological and research activities, in addition to the skills needed to develop, anticipate and react to the emergence of competing methods.

Having an inquisitive mind, and a willingness to challenge myself and those normally accepted methods early on in my career, has given me an engrained work ethos to tackle these challenges. My experience of working in both industry and academia provides a very good foundation to drive applied research through to maturity.

Working within the nuclear, aerospace, automotive and marine sectors has also allowed me to be more objective and considerate of the advantages offered by working in a cross-sector manner, and has aided in breaking down the silo mentality that you can find obstructing interactions between different manufacturing practices.

Developing and proving innovative technologies for nuclear manufacturing is not an easy task. The nuclear sector is understandably very conservative, so introducing new technologies that challenge existing codes and practices requires extremely strong de-risking procedures, reinforced by substantial data to justify their inception.

For many nuclear manufacturers, the key to increased competitiveness lies in doing more with current technologies and processes. I believe there are still significant benefits to be realised by optimising current practices and competences, through diligently analysing output data to generate process improvements. This approach accelerates performance and improves capability without needing a step change in skills transformation and unnecessary costs.

In the longer term, I see eight emerging game-changing technologies which will be vitally important to the future competitiveness of the UK nuclear supply chain (see box). Companies need to start thinking about these technologies now, and how they might affect their own production.

The Nuclear AMRC can help UK manufacturers take advantage of all of these technologies. As one of seven specialist centres within the High Value Manufacturing Catapult, we can access a national network of expertise and government funding to explore opportunities to develop new or improved manufacturing techniques.

By tapping into our £30 million worth of production-scale equipment in our research factory, our team of proficient and highly dedicated engineering personnel, and our extensive network of universities, engineering institutions and industry members, manufacturers can access a knowledge and capability hub which can service the full spectrum of our sector's needs.

I fully encourage all organisations with an interest in this energy sector to exploit our services to enhance their chances of being a partner of choice on a global scale.

Power beam: Steve Jones inside the Nuclear AMRC's Pro-Beam K2000 electron beam welding chamber.

Game-changing technologies

- **Additive manufacturing** opens up a vast array of fabrication flexibility.
- **Solid-state fabrication** methods in the form of hipping and bonding could improve through-structure properties and dissimilar material joining capability.
- **Collaborative robotics** offers exploitation in the area of skills development and hostile environmental working.
- **Intelligent and reconfigurable tooling** capable of simultaneously undertaking real-time inspection could minimise or negate several post-processing activities.
- **Flexible manufacturing platforms and product modularisation** offer significant cost reduction advantages.
- **Predictive analytics** can forecast if a future event will cause defects, machine breakdown or product failure.
- The suite of digital technologies dubbed Industry 4.0 offer the potential to create **connected or twin factories** to improve real-time monitoring and complete self-diagnostics, providing significant improvements in safety, reliability and systems quality control.
- Industry 4.0 also highlights the need to enhance **cyber security** for all aspects of manufacturing – this is increasingly a critical factor in winning nuclear work.

New head of welding

Dr Russell Hall, previously principal researcher at Tata Steel UK, has been appointed as the Nuclear AMRC's new head of welding.

Dr Hall will manage the welding group and lead industry-focused R&D using the Nuclear AMRC's arc, electron beam and laser facilities.

Dr Hall was previously principal researcher and electromagnetic NDE expert for Tata Steel UK's R&D business unit, based at the University of Warwick. He has held a range of technical and managerial roles in the heavy engineering sector, including oil and gas, cryogenics, pressure vessel manufacture, steel making and nuclear, often acting as a liaison between industry and academia.

He succeeds Professor Keith Bridger, who is stepping down at the end of the year after six years at the Nuclear AMRC and over 40 years as a nuclear-focused welding engineer.

CNSIG companies celebrate success

Manufacturing companies on the Civil Nuclear Sharing in Growth (CNSIG) programme came together in September to celebrate their success.

The CNSIG companies are now coming to the end of a four-year programme of business development and training, tailored to the specific needs of their business. This has included shopfloor manufacturing improvement, productivity improvements, leadership development, supply chain development and specific nuclear sector knowledge.

To date (end of September 2017), the participating companies have reported that CNSIG has helped them secure £507 million of orders, creating or safeguarding 6,040 jobs, and supported an additional £51.6 million private investment. The current programme comes to an end in December 2017.

Eight companies presented at the event about their progress through the programme (see right). They also contributed to a CNSIG video showcasing their progress and achievements, including awards and new contracts, which was screened at the event and is now available to view online.

CNSIG is a four-year programme to improve competitiveness in the UK civil nuclear supply chain, led by the Nuclear AMRC. It is part-funded by the Regional Growth Fund and Rolls-Royce, with each company supported by £1 million match-funding.

"CNSIG was designed to help the UK supply chain maximise its opportunity with the impending growth in the sector through decommissioning and new build activity," says Jonathan Matthews, supplier development executive at Rolls-Royce. "We developed a very rich programme with a big focus at the beginning on data and KPIs. There was also a lot of work around employee engagement, which was probably the most critical element of the entire programme – tools and techniques are important but if you don't engage the people on the programme, you aren't going to succeed."

The companies are now in the final sustain phase of the CNSIG programme, and working to ensure that the improvements introduced over the past few years continue to help them improve business performance and win new work.

"It's been great to see the management teams in the participating companies develop themselves through the journey of performance improvement, and to leave them in a position where they're able to deliver on their potential," Matthews says.

The event also included presentations from Ken Owen, commercial director at EDF Energy; Ron Gorham, head of supply chain optimisation for Sellafield Ltd; and Chris Tierney, executive vice-president for projects, systems and supply chain at Rolls-Royce.

For more information on the programme and to watch the video: **namrc.co.uk/services/sig**

CNSIG won the Capability and Capacity Award at the NDA supply chain awards 2017.

The annual awards recognise the vital contribution of suppliers to the UK's nuclear clean-up mission. Winners were announced at the NDA Estate Supply Chain Event, held in Manchester on 2 November.

£507 million
new orders won

6,040
jobs created
or safeguarded

£51.6 million
additional private investment

Slice of the cake: managers from the CNSIG companies celebrate their success in winning new work.

L–R: Matthew Goodwin, *Goodwin International;* **Ross Meikle,** *Hayward Tyler;* **Austen Adams,** *Stainless Metalcraft;* **John Coughlan,** *TSP Engineering;* **Gary Mottershead,** *James Fisher Nuclear;* **Gill Marsden,** *NIS;* **Ken Owen**, *EDF Energy;* **Tony Maxwell,** *IMI Truflo Marine;* **Zoe Jeavons,** *Ansaldo NES;* **Jonathan Matthews,** *Rolls-Royce;* **Chris Tierney,** *Rolls-Royce;* **Ron Gorham,** *NDA.*

Ansaldo Nuclear

A provider of design, manufacture, test, commissioning, installation and training services for the nuclear decommissioning, defence and new build markets, based in Wolverhampton.

CNSIG supported work towards securing the nuclear quality management standard ISO 19443 and welding qualification ISO 3834, as well as training packages tailored to business needs.

Goodwin International

A specialist heavy precision engineer based in Stoke-on-Trent, offering supply of material, machining, fabrication, assembly and design of components up to 100 tonnes.

Goodwin implemented a range of business improvements to help grow its sales into nuclear decommissioning and new build, and has recently bid for significant work with Magnox.

Hayward Tyler

One of the world's leading suppliers of electric motors and pumps, based in Luton with offices worldwide.

CNSIG helped the firm implement a new business strategy, drive continuous improvement through production leadership, and realise £1 million of cost reductions through strategic purchasing.

IMI Truflo Marine

Birmingham-based producer of high-integrity valves and actuators for critical applications, including naval marine and civil nuclear.

The firm focused on lean improvement, significantly increasing on-time delivery performance and machine shop equipment effectiveness, and also introduced consistent project management practices across the business.

James Fisher Nuclear

Lancashire-based supplier of specialist engineering, manufacturing and technical services for high-integrity applications.

With CNSIG support, the firm focused on employee engagement and its business development process, developing a new visual system to identify opportunities and subsequently doubling its ratio of successful bids.

NIS Ltd

Chorley-based specialist integrated engineering company, providing bespoke design and manufacture of plant and equipment for a wide range of markets.

NIS used CNSIG support to launch a new business management system to demonstrate compliance and control to customers and auditors, and developed key strategic partners to minimise risk in its own supply chain.

Stainless Metalcraft

A leading designer and manufacturer of pressure vessels, tanks and other systems for the energy and metal sectors, based in Cambridgeshire.

CNSIG supported strategic development, work towards ISO 19443, advanced apprentice training, and development of a manufacturing centre of excellence to fulfil a major new contract with Sellafield Ltd.

TSP Engineering

A leading provider of design, manufacture and construction services to a variety of industrial sectors, based in York and Workington.

TSP's CNSIG journey focused on developing its project management and performance measurement capabilities, resulting in clear improvements to on-time delivery of projects.

F4N
Fit For Nuclear

Fit and they know it: delegates from F4N companies show off their new certificates.

Fit for the future

Sixty Fit For Nuclear companies came together to celebrate their success and help plan the next stage of the Nuclear AMRC's flagship supply chain development programme.

Delegates heard about the latest developments to the Fit For Nuclear (F4N) programme, including a three-year certification process and new online directory of F4N companies, and discussed the future expansion of the programme.

F4N is a unique service which lets manufacturers measure their operations against the standards required to supply the nuclear industry – in new build, operations and decommissioning – and helps them take the necessary steps to close any gaps. F4N is delivered exclusively by the Nuclear AMRC, and supported by top-tier partners in nuclear new build and decommissioning.

Around 650 companies have now taken the initial online F4N assessment, and some 130 have completed the current programme and been granted F4N status. F4N-granted companies now represent over £2 billion turnover of UK manufacturing, nuclear specialist Martin Ride told delegates at the event. "Our programme is really reaching out to some pretty big companies now," he said.

The F4N team have continually refined and developed the programme since its launch in 2011, in response to market demand and feedback from participating companies. This year, the Nuclear AMRC established a F4N steering group made up of manufacturers, reactor providers, new build developers and decommissioning site owners to ensure that the programme continues to meet the needs of the UK nuclear industry.

The main priority identified by the steering group is to provide additional ongoing support to companies after granting, to help them maintain their journey of business excellence and identify and win opportunities across the nuclear sector.

The launch of the new programme of post-granting support was marked at the event with new F4N certificates presented to all attending companies. Certificates have also been posted to all F4N-granted companies which couldn't attend. These dated certificates are valid for three years after granting, with the F4N industrial advisors providing ongoing support and six-monthly site visits over this period. The company can then take a re-assessment and be certified for another three years.

The event also launched F4N Connect, the new online directory for F4N companies (see right). Delegates were urged to complete their entries before the site is opened up to nuclear buyers.

The 82 delegates, including members of the F4N steering group, then took part in an open discussion of proposals for further development of the programme. The most popular suggestions were around help in identifying opportunities to tender for nuclear work, and support in preparing bids. There was also strong support for international benchmarking for the competitiveness of national supply chains, and for nuclear buyers' pre-qualification questionnaires (PQQs) to ask for F4N status as a standard.

The F4N companies also showed strong interest in regional collaborative networks to share best practice and bid for larger contracts. "There's quite a few companies that have met and come together and

Congratulations to the latest companies to be granted Fit For Nuclear over the past quarter.

These companies from around the UK have benchmarked their performance against the standards demanded by the civil nuclear industry's top tiers, and driven business improvements through a tailored action plan.

For details of all F4N companies plus case studies:
namrc.co.uk/services/f4n/companies

Costain Integrated Technology Solutions specialises in consultancy and design of bespoke security and highways systems; and the design, development, manufacture, testing, installation and maintenance of high end technical equipment.
www.costain.com

Devoran Metals is a leading specialist supplier of CARES-approved cut and bent reinforcing bar and mesh for concrete reinforcement, providing bespoke rebar solutions, prefabricated reinforcement, construction accessories and coupler systems.
www.devoran-metals.co.uk

Fairford Electronics is an innovator, designer and manufacturer of soft starters and energy-saving motor control equipment. See case study, p14.
www.fairford.com

Fairham Mouldings provides solutions for all precision rubber component applications, using a full range of special elastomers. The firm's in-house CAD/CAM mould-making facilities enable it to produce bespoke mouldings.
www.fairham.com

IT4Automation is a specialist operational technology network solutions company, operating in the nuclear industry since 2014.
www.it4automation.com

Newburgh Engineering has continuously provided precision engineering components and assemblies to the nuclear sector since the 1950s, and is still achieving outstanding results as the supplier of choice for its customers.
www.newburgh.co.uk

PSL Assemblies manufactures power semiconductor stack assemblies and power electronic thermal management solutions, with over 40 years of manufacturing excellence in the supply of custom-built heat sinks, cooling plates and semiconductor stack assemblies.
www.psl-group.uk.com

South West Metal Finishing Ltd, part of the EIC Group, offers a bespoke service on most metal finishing processes including electro-plating, anodising, surface conversion coatings, non-destructive and other testing services, painting and additive layer surface enhancement.
www.eicgroup.co.uk

are working on contracts because of this programme," said Martin Booth, managing director of Witt UK and chair of the F4N steering group, in his summing-up. "The F4N programme will become best practice."

The event also featured Toby Bailey, business development director at RED Engineering, talking about the Hexham-based company's journey to diversify from its core oil and gas business with support from F4N (see over).

The day finished with an open tour of Nuclear AMRC workshop, with engineers and technicians presenting technologies and capabilities of particular interest to smaller manufacturers, from advanced machining coolants to narrow-gap welding. Delegates also had the opportunity to discuss current collaborative R&D funding calls from Innovate UK.

Start your F4N journey:
namrc.co.uk/services/f4n

F4N Connect is the new online directory for Fit For Nuclear companies. F4N granted companies can submit their details for a free listing, including their manufacturing capabilities, products and services, testimonials and accreditations.

Nuclear buyers can then search for qualified suppliers who can meet their specific needs, with the confidence that all listed companies have been awarded Fit For Nuclear status. Buyers can search by company capabilities, products and services, facilities, qualifications, current sectors or location.

F4N Connect is managed and promoted by the Nuclear AMRC, but companies are responsible for their own information.

connect.f4n.namrc.co.uk

F4N
Fit For Nuclear

RED gets ahead for nuclear

Toby Bailey, business development director at RED Engineering, explains how Fit For Nuclear helped the company expand from its core oil & gas business into nuclear decommissioning.

RED Engineering (formerly RED Marine) is a firm of highly skilled engineers working to help industrial and manufacturing customers to cut risk, achieve cost savings, shorten schedules and operate safely. Our expertise revolves around the development of engineering solutions covering installation, maintenance and decommissioning activities. Our services span engineering consultancy, fast-track design, build of bespoke equipment and qualification testing.

Off the back of a successful track record in the offshore oil and gas sector, we identified nuclear decommissioning as an area where we could add value through the transfer of our existing core skills and expertise. A key driver was to diversify our business into new market areas beyond the offshore sector to secure the future growth and development of RED.

As we had limited experience in the civil nuclear arena, we entered the F4N programme to provide independent validation and to enhance our credibility, enabling us to work successfully as a supplier to the sector.

The assessment identified that the way we manage the visibility of company target and performance information to our workforce could be improved. It also noted that we did not have an active system in place for safety observations. There were no big surprises, but we now have a more comprehensive, rounded understanding of the cultural approach to health and safety within the nuclear industry. Consequently, we have become more self-aware of potential hazards in the working environment.

Senior staff have now completed Triple Bar training and cultivated a better understanding of the high standards that we need to achieve along with the responsibilities we owe to our employees, suppliers and clients. We now display KPIs on the wall of our test facility, including metrics regarding client satisfaction and the completion of continual improvement actions.

We have also introduced a new observation reporting system that has contributed to unlocking the flow of ideas from our staff regarding safety improvement and the continual improvement of processes and facilities. This has been our most useful new initiative.

The F4N programme has enabled us to ramp up our activity in the nuclear sector, approaching Tier 2 suppliers in a project-ready state, with the confidence that we have the capacity to provide a suitable level of service for the industry. F4N has given us the confidence boost that we are compatible with nuclear demands, and has helped us gain AVL status with new clients in the sector. It has boosted our profile, and we do see it as a real badge of honour.

Two years in, we're now working as consultants with two tier two contractors at Sellafield. We're close to being able to supply our first piece of equipment to Sellafield, and are named partners in two Innovate UK funded projects.

Nuclear this year will be 10 per cent of our turnover – this time last year, it was zero.

Our ambition is to be a trusted engineering partner within the nuclear sector, delivering equipment and expertise to support the industry in its goal to improve the current approaches to decommissioning power plants. We want to establish partnerships to deliver turnkey solutions, and aim to be the go-to company for complex challenges where a fresh approach, new thinking and cutting-edge industrial technologies are required to successfully complete a decommissioning task.

redengineers.co.uk

Royal approval: Toby Bailey (front right) and the RED Engineering team accept the Queen's Award for Enterprise in Innovation from the Duchess of Northumberland.

Wylfa Newydd: Horizon Nuclear Power plans to build two ABWRs on Anglesey.

Extra support for **Welsh manufacturers**

Up to 50 manufacturers in Wales are now beginning their Fit For Nuclear journey with support from the Welsh Government.

In July, economy secretary Ken Skates announced a second tranche of funding worth £450,000 to support 50 Welsh companies through the Fit For Nuclear programme. The funding follows a successful pilot programme in 2016 which supported 20 Welsh companies through F4N.

"The nuclear sector will provide a wide range of business opportunities over the next 10–15 years and we want to ensure that businesses in Wales are in a position to bid for and win a share of this business," said Skates. "Research has identified that Welsh businesses have the potential, with the relevant accreditations and organisational systems, to compete for a significant proportion of nuclear sector contracts both in Wales and further afield."

More than 60 companies registered their interest in the programme. Applications were appraised by a review panel including F4N industrial advisors Huw Jenkins and John Olver and Welsh Government officials.

The panel shortlisted 43 companies as having the potential to succeed in nuclear, with others under further consideration.

The companies have been invited to events in North and South Wales in early November to find out more about what the F4N journey involves, and speak with other Welsh manufacturers who have successfully completed the programme or are currently working towards granting.

"The Welsh companies currently working through the F4N programme have highlighted the wealth of high-quality manufacturers in Wales which could meet the demands of the nuclear industry," said Helen Arthur, supply chain development programme manager at the Nuclear AMRC. "We are very excited to continue working with the Welsh Government to make sure that more Welsh manufacturers can access our support and get ready to win work in the nuclear supply chain at home and worldwide."

F4N's new man in the North

Manufacturers in the North of England have a new champion to help them meet the demands of the nuclear sector.

Experienced engineer and manufacturing consultant Nigel Goodrich has joined the Nuclear AMRC's Fit For Nuclear team as industrial advisor covering Cumbria, North Yorkshire and Northumberland.

"I'm looking to support any manufacturer that wants to help themselves improve their business, to increase their opportunity of supplying into the nuclear supply chain," Goodrich says. "They will need a critical focus on excellence, and an increased focus on health and safety above what many businesses might consider good practice."

Goodrich previously worked for the Manufacturing Advisory Service (MAS), and most recently covered Cumbria and Lancashire for the Greater Manchester business growth hub. He started his career as a graduate apprentice engineer at British Aerospace, and worked in engineering, quality, manufacturing and supply chain development for Rover Group, BMW and Jaguar Land Rover before becoming a consultant. He lives in Lancaster.

"I have always worked with manufacturers to improve their quality, cost and output," he says. "As part of the F4N team, I help take the business through a business excellence model – our on-site verification helps to identify a gap analysis, and I then provide critical help with an action plan. You might view F4N as a soft audit to ensure the customer is much better able to pass a potential nuclear buyer's audit."

For an informal discussion with the F4N industrial advisor for your region, email: **f4n@namrc.co.uk**

F4N helps Fairford motor ahead

Specialist manufacturer Fairford Electronics has driven business improvements and is targeting new nuclear opportunities after completing the Fit For Nuclear programme.

Eye-opening experience: managing director Mark Shepherd.

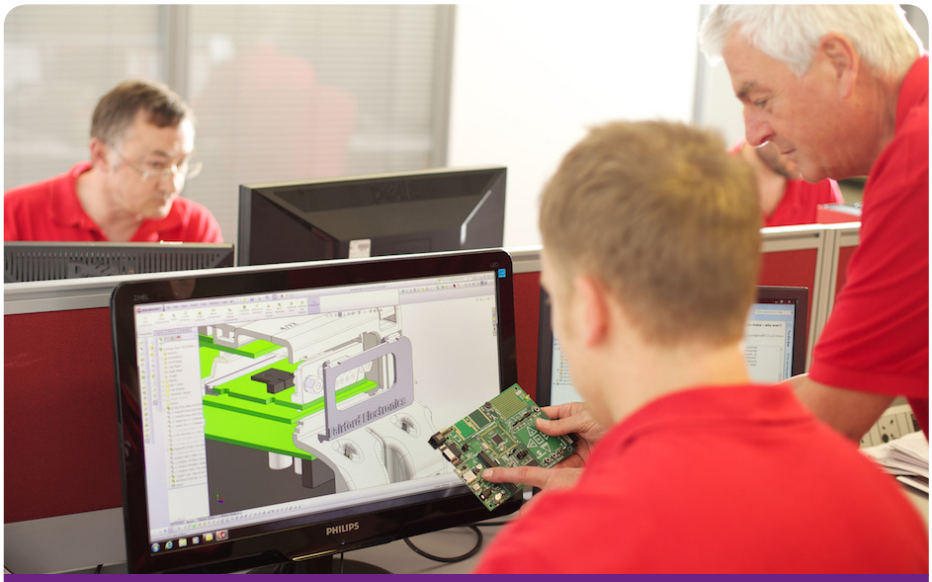
Based in Ivybridge, Devon, Fairford designs and produces soft starters for electric motors. Without a soft starter, electric motors try to accelerate to full speed in an instant, drawing a significantly greater current and creating proportionately higher torque.

"That puts a huge amount of strain on the electrical system and the mechanical load, which can appear as screeching belts, broken gearboxes or heat," says Mark Shepherd, managing director at Fairford. "A soft starter gradually increases the amount of energy available to the motor, allowing the motor to accelerate over a defined period – that can be a few seconds, or up to 15–20 minutes for a large centrifuge."

Typical industrial applications include pumps, conveyor belts and fans. In a nuclear power station, they have numerous applications outside the primary circuit such as secondary pumps and ventilation systems, as well as turbine starter systems where they are used to bring the rotor up to speed before the steam is applied.

The Fairford team learned about F4N from contacts at the South West Manufacturing Advisory Service. "They came and talked to us about F4N and, with Hinkley Point C being only 85 miles away, it seemed like a good opportunity to develop the business and to expand into new markets," Shepherd says. "We considered the business to be well managed, but when the F4N assessment came back it was quite an eye-opener. We could understand the level of expectation in the nuclear industry, but we had never considered it from that viewpoint before."

The main areas identified for development were around employee engagement and management of continuous improvement. "We're a small company with 35 employees on one site, and we'd taken employee engagement pretty much for granted," Shepherd notes. "And we were continuously improving things within the business, but there was little structure it or evidencing of it."



Bespoke service: Fairford designs soft starters for many applications.

Head of quality Jonathan Atkins led the development programme, including adopting the Basecamp online collaboration tool to let all staff share and discuss ideas and information. The firm also put three employees through a nine-month programme of training in business improvement techniques, with more colleagues now beginning the course.

"One of the big features of F4N for me was it helped us raise our expectations," Atkins says. "We looked at what's used in other industries and how we could appropriately apply those techniques within our business."

Health and safety probably caused the least concern, Shepherd says: "We had a good health and safety system which was fit for our purposes, but it just needed some

minor tweaks to bring it in line with the expectations of the nuclear industry."

The F4N programme was originally designed for manufacturers operating in various areas of mechanical engineering, but the Fairford team found no problems in working through the programme as an electronics manufacturer.

"Our main production activity is product assembly – whether you're handling a welder, a mill or a screwdriver, you still have a person making a product," Shepherd notes.

"It would have been slightly different for us as an electrical manufacturer, but for the fact that our product is already highly regulated," Atkins adds. "We were used to doing a lot of testing and having quite a high level of traceability of our products. When the nuclear assessors started talking about traceability, we already knew about that as we'd been doing it ever since the company started."

F4N has hugely benefited the business by driving business improvements, the team say. "It's always useful to have an overarching objective, and that's what the F4N programme has given us," Atkins says. "It lets us show people there's a reason for what we're doing. It's a really useful way of engaging everybody and showing that we know how to work to higher standards."

Fairford primarily sells its soft starters to OEMs and through distributors, with over 85 per cent being exported, and the team doesn't foresee significant direct sales to nuclear buyers. "For us, F4N is a good accolade to have, but we're not going to generate huge amounts of extra business or margins from it," Shepherd says. "The value for us is the improvements it's made to the business, and being able to show to OEMs and brand label customers that our business processes do meet this level. And it has improved the general business."

The programme has raised the team's awareness of opportunities in and around the sector, Atkins adds. "When you look at the infrastructure around Hinkley Point C there are many opportunities for our products," he says. "They're building Europe's biggest concrete mixing plant on-site – our products could be used there. Our products can be used anywhere there's an electrical motor, and the number of motors being used to build Hinkley Point is going to be huge."

www.fairford.com

Circuit training: F4N principles apply equally to electronics assembly.

Start your F4N journey: **namrc.co.uk/services/f4n**

namrc.co.uk/news/events

Diary

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 2017

7 December, London

The Nuclear Industry Association's annual conference and dinner, bringing together speakers from all parts of the nuclear industry to review the year and see what 2018 has in store. Andrew Storer, Nuclear AMRC chief executive, will present on supply chain opportunities.

nuclear2017.co.uk

DIT Civil Nuclear Showcase

27–28 February 2018, London

The Department for International Trade presents a a unique opportunity to network with a diverse mix of senior delegates from all around the world, including China, France, Japan and South Korea. The event includes country briefings and one-to-one meetings with overseas delegates.

www.events.trade.gov.uk/dit-civil-nuclear-showcase-2018

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 **supplier 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 business development director:
jay.shaw@namrc.co.uk

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