NUCLEAR AMRC news

No.39 Autumn 2020

Powering up for recovery

Nuclear innovation to drive sustainable growth

CATAPULT
High Value Manufacturing

Welcome back to *Nuclear AMRC News*

We suspended the usual quarterly schedule for this newsletter at the start of the Covid-19 lockdown in the spring, to concentrate on our online channels. Our priority was sharing timely news and information which our network could easily access wherever they were – working from home, carrying on with essential manufacturing, or contributing to the national effort on PPE and ventilator production.

We now bring you this bumper issue to cover all the developments since our last edition in January. Like many of you, we've had to change the way we work to manage the risks of Covid, and to respond to the impact of the pandemic on our customers and partners. We've continued to support manufacturers of all sizes across the UK, and have secured new funding and started some major new research projects to help drive our nation's economic recovery.

Things are still a long way from normality for many of us, but the Nuclear AMRC is very much open for business.

We are aiming to resume our normal schedule for the newsletter in the new year. If you have any suggestions for the kind of story or information you'd like to see, to inform and inspire you to further success in the nuclear supply chain, please do get in touch.

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Science minister visits to map the future of research

Science minister Amanda Solloway visited the Nuclear AMRC in August to discuss how applied innovation in low-carbon nuclear power and advanced manufacturing can help power an economic recovery across the UK.

During her tour of the Nuclear AMRC workshop in Rotherham, CEO Andrew Storer highlighted the potential of electron beam welding and other techniques for the cost-effective production of small modular reactors, and work to support manufacturers nationwide through the Fit For Nuclear programme.

Solloway and her BEIS colleagues were the first visitors to the Nuclear AMRC since Covid-19 restrictions were introduced in March. The visit was carefully managed to minimise any health risk to the visitors or staff, in line with the centre's painstaking approach to safeguarding staff health (see p16).

The minister also met Professor Koen Lamberts, University of Sheffield Vice-Chancellor, and apprentices at the AMRC Training Centre, and took part in a virtual roundtable to discuss the government's new R&D roadmap with industry leaders, senior researchers and regional stakeholders.

Inside innovation: Andrew Storer and Koen Lamberts welcome Amanda Solloway to the Nuclear AMRC.

Published in July, the roadmap sets out proposals to invest in science and research to deliver economic growth and societal benefits across the UK for decades to come, and to build the foundations for the new industries of tomorrow. The government plans to increase public investment in R&D to £22 billion by 2024–25.

www.gov.uk/government/publications/uk-research-and-development-roadmap

Funding secured for **Nuclear AMRC Midlands**

The Nuclear AMRC's proposal to establish a new advanced manufacturing research centre in Derby has secured government funding.

Infinity and beyond: design for the new facility in Derby.

The proposal, supported by Derby City Council and the D2N2 Local Enterprise Partnership, was awarded £6.85 million in August by the Ministry of Housing, Communities & Local Government.

Local partners will also invest in the £20 million project to create a new permanent home on Derby's Infinity Park for Nuclear AMRC Midlands, creating 70 jobs and helping to reboot the local economy after the Covid-19 crisis.

"We're delighted to have received government support for our manufacturing research centre on Infinity Park, and look forward to continuing our work with Derby City Council, regional universities and businesses to deliver jobs and support the economic recovery of the region," said Dr Emma Kelly, Nuclear AMRC strategy director.

The investment follows a successful pilot project over the past 18 months, with the growing Nuclear AMRC Midlands team operating from workshops and offices within the iHub facility on Infinity Park, creating the first High Value Manufacturing Catapult centre in the East Midlands region.

The team have developed new capabilities in technology areas including controls and instrumentation, digital engineering and additive manufacturing, and worked with companies of all sizes to help them innovate and win work.

The new facility, with around 5,000m^2 of floorspace, will further extend the Nuclear AMRC's ability to help manufacturers develop and adopt innovative technologies which will deliver the maximum impact for the UK's nuclear supply chain.

"Nuclear generation is a vital part of the energy mix for clean electricity and meeting the UK's net zero commitment," Kelly said. "We will work alongside regional industrial partners to ensure a suitably qualified supply chain that is able to capitalise on advanced nuclear technologies within the clean energy sector."

The facility will also be a base for the University of Derby's Institute for Innovation in Sustainable Engineering (IISE), which has developed an international reputation for innovation in design, manufacturing, product lifecycle management and the application of new and smart materials.

IISE includes a Rail Research and Innovation Centre to support collaborative research and innovation projects with local rail supply chains. It also leads the DE-Carbonise project, offering comprehensive support to SMEs which want to reduce carbon emissions in their operations, production and supply chain.

The project is viewed as a key part of Derby's post-Covid economic recovery strategy, and will provide local businesses with access to cutting-edge R&D facilities to help them diversify, grow and create new jobs.

The government funding comes from the Getting Building Fund, which is investing £900 million in shovel-ready infrastructure and housing projects across England. The D2N2 region, which covers Derbyshire and Nottinghamshire, secured a total of £44.4 million for projects including a high-tech food manufacturing campus in Derby, a 5G innovation hub in Worksop, and a digital advanced manufacturing and engineering centre in Chesterfield.

New projects to drive **nuclear innovation**

The Nuclear AMRC is part of four new manufacturing R&D collaborations supported by the Nuclear Innovation Programme, and is working with advanced modular reactor developers to progress their technologies with UK government support.

The projects are part of a £40 million funding package to kickstart the development of next-generation nuclear technologies and unlock thousands of jobs in the low-carbon energy sector.

Around £5 million total has been awarded to seven new R&D projects through the advanced manufacturing and materials competition (phase 2B), part of the Nuclear Innovation Programme. All the collaborative projects are led by UK companies, including several SMEs.

The Nuclear AMRC is part of four projects:

- **Awesim, led by Cavendish Nuclear,** to develop automated inspection and monitoring techniques for high-quality welding.
- **Research with Createc and TSP Engineering** to improve the safety and performance of radiographic weld inspection.
- **SonicSMR, led by Laser Additive Solutions,** to develop high-quality additive manufacturing techniques for small modular reactor components.
- **PITCO2C, led by Nuclear Energy Components,** to develop supercritical carbon dioxide coolant for nuclear machining.

See the following pages for more information on these projects.

The other new funded projects are led by U-Battery, to design and build key components for its compact reactor; Rolls-Royce, to develop novel sensor technologies; and Jacobs, to develop enhanced evaluation technologies for future reactor plant.

The £180 million Nuclear Innovation Programme is part of BEIS's wider £505 million Energy Innovation Programme, which includes investment in industrial decarbonisation, carbon capture, energy efficiency and other low-carbon technologies.

The programme also includes support for generation IV advanced modular reactors (AMRs), through an AMR feasibility and development competition.

In 2018, eight organisations won an initial grant to produce feasibility studies on their reactor designs. Now, in the competition's second phase, Westinghouse, U-Battery and Tokamak Energy have each been awarded £10 million to bring their AMRs closer to market (see opposite).

"Advanced modular reactors are the next step in nuclear energy and have the potential to be a crucial part of tackling carbon emissions and climate change," said business minister Nadhim Zahawi. "Today's investment will immediately create new jobs in Oxfordshire, Cumbria and Lancashire. But through this vital research, the technology could also create thousands more green-collar jobs for decades to come."

The government is also investing £5 million to strengthen the UK's nuclear regulatory regime for advanced reactors, and has released a report from the Nuclear AMRC and NNL on the readiness of the UK's supply chain and research base to develop and produce AMRs (see p12).

The funding is part of the Nuclear Sector Deal launched in 2018.

Advanced modular reactors

Westinghouse – lead-cooled fast reactor

Westinghouse, a founding member of the Nuclear AMRC, is developing a high-temperature fission reactor which will allow flexible generation to balance intermittent renewable sources.

Westinghouse's 450MWe lead-cooled fast reactor (LFR) features a simplified design, flexible operations and fuel cycle capabilities, walk-away safety features and modular assembly. Using molten lead as primary coolant allows for efficient high-temperature operation at atmospheric pressure, without any risk of the coolant boiling off or reacting with other materials.

Westinghouse UK will work with industry, research and academic partners to advance the LFR design, demonstrating key components and accelerating the development of high-temperature materials, advanced manufacturing technologies and modular construction strategies.

Industry partners include Frazer-Nash Consultancy, Jacobs, Ansaldo Nucleare and Vacuum Process Engineering. Research partners include the Nuclear AMRC, NNL and Italy's ENEA, with academic support from Bangor University, the University of Cambridge and The University of Manchester.

"This is the perfect combination of reducing the cost of electricity and maintaining a leading edge of science, research and innovation for the UK," said Patrick Fragman, Westinghouse president and CEO.

Westinghouse proposes to build development facilities for the LFR at the Clean Energy Technology Park (CETP) at its Springfields site in Lancashire. Launched in February and supported by the Nuclear AMRC, the CETP aims to support innovation and collaborative partnerships, and bring highly-skilled jobs to the north-west of England.

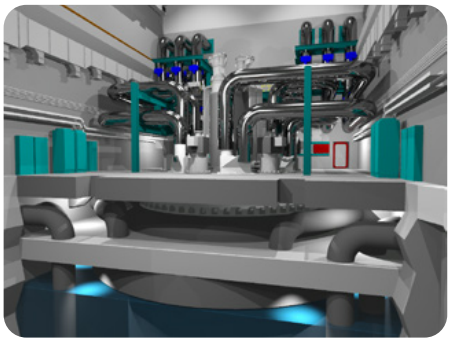


Image: Westinghouse Electric Company

www.westinghousenuclear.com/new-plants/lead-cooled-fast-reactor

cetpspringfields.com

U-Battery – industrial power and heat

U-Battery, a subsidiary of Urenco, is developing a small high-temperature gas-cooled fission reactor for industrial applications including hydrogen production.

The government funding allows U-Battery and partners to initiate design and development work this year, and work towards first deployment by 2028.

U-Battery is designed to be deployed at energy-intensive industrial sites and remote off-grid locations. It uses the proven Triso fuel, based on spherical pellets of triple-coated uranium. The reactor design also uses modular and off-site construction to reduce construction cost and risk.

"U-Battery has been identified as an excellent potential solution for the supply of low-carbon industrial heat, which will support the decarbonisation of a number of heavy and energy intensive industries here in the UK, and enable them to continue to operate as we decarbonise the economy and strive towards delivering net zero by 2050," said general manager Steve Threlfall.

Urenco will also look to form new commercial partnerships to support development. U-Battery is already supported by Jacobs, Kinectrics, Cavendish Nuclear, Rolls-Royce, BWXT, Mammoet, NNL and the Nuclear AMRC.

Image: U-Battery

U-Battery has also received funding from BEIS to design and build mock-ups of the two main vessels for the reactor and the connecting duct.

www.u-battery.com

Tokamak Energy – compact fusion power

Tokamak Energy is developing the ST40 spherical tokamak fusion reactor, with the aim of building a first commercial plant by 2030.

Oxfordshire-based Tokamak was founded in 2009 by former staff at UKAEA's Culham Centre for Fusion Energy. The new funding will contribute to the development of high-temperature superconducting magnets to control the plasma, as well as divertor technologies to extract waste material.

"I am pleased that our hard work to demonstrate that fusion energy can be delivered at scale in a cost-effective and regulatory-compliant way has been recognised by BEIS," commented Jonathan Carling, CEO of Tokamak Energy.

The government-funded development will see Tokamak work alongside Cern and Qdot Technology Ltd, with research support from the University of Oxford, University of Illinois and Oak Ridge National Laboratory.

The funding was welcomed by UKAEA, the publicly-owned fusion developer. "This is really good news – not just for Tokamak Energy, but also for the wider fusion community," said CTO Tim Bestwick.

www.tokamakenergy.co.uk

Nuclear Innovation Programme

Automated weld inspection and monitoring

The Awesim project builds on previous Nuclear AMRC research to develop automated inspection and monitoring techniques for high-quality welding.

Cavendish Nuclear, part of Babcock International and a member of the Nuclear AMRC, is leading the £2.1 million project which combines machine learning, sensor development and advanced remote manufacturing processes to deliver welding and inspection – and potentially weld certification – in close to real time.

The proposed technology will enable early detection of flaws as they occur, reducing rework, repair and mid-stage weld inspections, and delivering significant cost and time savings.

Awesim (Automated Welding Equipment System Inspection and Monitoring) will build on research led by the Nuclear AMRC in the Simple project funded by an earlier round of the Nuclear Innovation Programme.

Simple (Single Manufacturing Platform Environment) developed a range of digital manufacturing techniques, which the Nuclear AMRC team successfully demonstrated on a prototype integrated welding and monitoring tool.

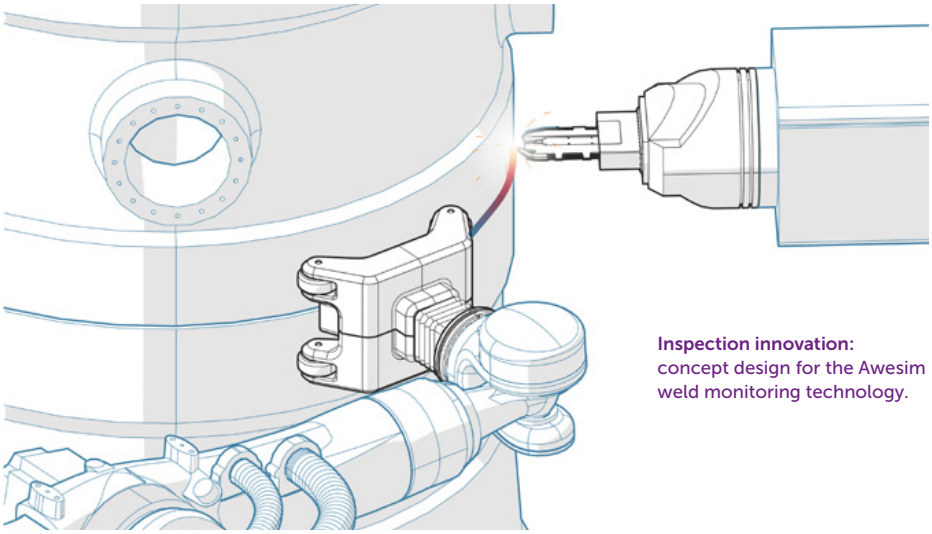
The Nuclear AMRC will build a factory-scale demonstrator of the Awesim technology at its Rotherham facility later this year.

The Awesim collaboration also includes the University of Strathclyde's Advanced Nuclear Research Centre and Derbyshire-based Peak NDT.

Cavendish Nuclear will work in collaboration with its sister company Doosan Babcock to ensure the technology is industry-ready.

"We've initially developed Awesim for the nuclear sector, but any industry developing large-scale critical assets involving high-integrity welding processes will benefit from what it will deliver," noted Tony Burnett, head of innovation and technology for Cavendish Nuclear.

www.cavendishnuclear.com



Inspection innovation: concept design for the Awesim weld monitoring technology.

Robotic weld radiography

Cumbrian technology development company Createc is working with partners on a robotic system to inspect the most challenging welds.

The project focuses on improving the safety and performance of weld radiography, an essential stage of inspection for many welds in safety-critical assemblies for the nuclear, aerospace and marine industries.

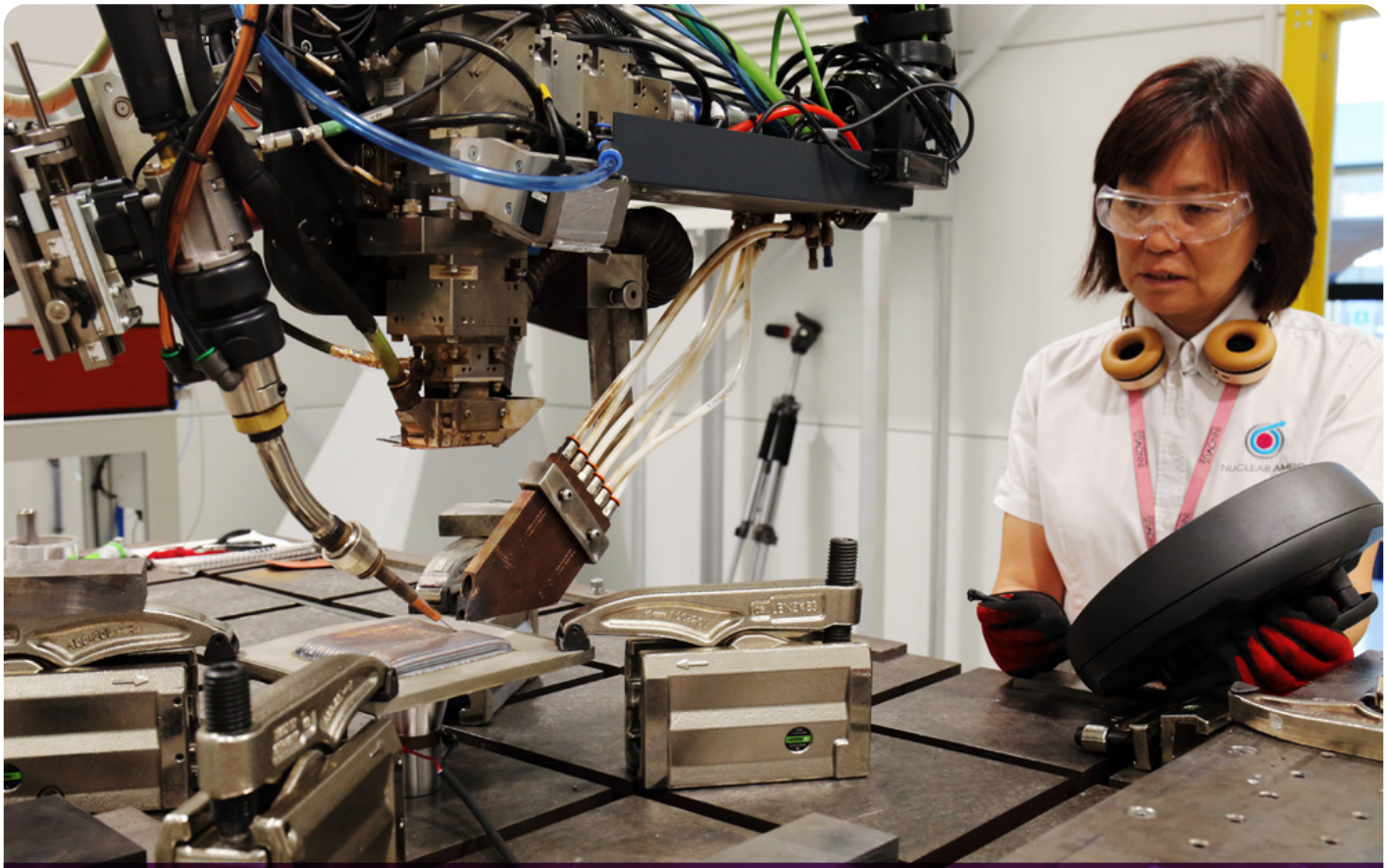
"Weld radiography is a mainstay of weld inspection but has two considerable drawbacks when deployed in situ: it is potentially hazardous, making its use obstructive and dangerous, and it does not reliably detect certain types of defect," commented David Clark, operations director for Createc.

Createc's concept combines autonomous robotics with 3D position-sensing techniques for computed tomography (CT) weld inspection. The technology promises to be safer and less obstructive, and offer higher performance than other established techniques.

"One of the key innovations is the ability to achieve the accuracy required for CT with independent robotic systems on either side of the weld," said Clark. "This would allow the system to be used in a wide range of applications, not limited by having to physically co-locate the two robotic systems."

The Nuclear AMRC and TSP Engineering are working with Createc to provide technical and market expertise in CT, radiography and ultrasonic capability, and to quantify and compare inspection performance.

www.createc.co.uk



Sound benefits: welding engineer Xiaoying Honey trials the SonicSMR technology in the Nuclear AMRC's disk laser cell.

Additive manufacturing for SMRs

The SonicSMR project aims to develop a high-quality additive manufacturing process for small modular reactor components.

Metal additive manufacturing has become a standard tool in sectors such as aerospace and automotive, and is seeing increasing interest from the nuclear sector for new reactor designs and to replace legacy parts in operating plant.

Concerns over material quality and process control have meant that adoption has been slow, however. Current techniques can result in porosities or poor fusion between layers which can increase the risk of cracking.

SonicSMR aims to overcome these problems by using power ultrasonics to improve material properties, with real-time process monitoring and AI-based defect recognition to ensure quality. The research will improve the quality and efficiency of additive manufacturing for a range of metals, and open up new capabilities for product customisation and design development.

The key to the project is using high-power ultrasonic technology to improve the components' material properties. Creating and collapsing minuscule bubbles in the molten metal – a technique known as acoustic cavitation – can reduce the risk of residual stresses forming as the metal cools and solidifies.

The Nuclear AMRC is working with Brunel Innovation Centre to develop the ultrasonic technology.

"We are conducting controlled experiments using our disk laser cell to manufacture scaled representative metal additive components, with positive results from the proof-of-concept trials," explained Dr Shehan Lowe, technical manager for the project at the Nuclear AMRC.

"All components manufactured in the trials have undergone thorough inspection to assess the built quality and benchmark against the current state of the art. The next stage is to integrate all sub-components into the disk laser cell, and start optimising the process."

The project draws on the Nuclear AMRC's previous research in power beam additive manufacturing, as well as the Simple project to develop automated weld monitoring techniques.

The project is led by Laser Additive Solutions Ltd (LAS), a Doncaster-based SME specialising in additive manufacturing and repair for aerospace and other industries. Other research partners include Derby-based Ivy-Tech Ltd, and University of Nottingham spin-out Taraz Metrology.

Following initial trials on the Nuclear AMRC's disk laser cell, LAS will create a fully operational additive cell at its own facility to test and demonstrate the technology.

www.laseradditivesolutions.co.uk

Nuclear Innovation Programme

Supercritical CO_2 coolant for high-performance machining

Nuclear Energy Components (NEC) is working with the Nuclear AMRC to develop environmentally-friendly machining techniques which will reduce the cost, lead time and risk of high-value nuclear components.

Derbyshire-based NEC specialises in metal components for the nuclear industry, including stainless steel parts for the fuel assemblies used in the UK's fleet of advanced gas-cooled reactors. These intricate components are machined using traditional emulsion-based coolants, resulting in large volumes of liquid waste and contaminated metal chips.

Over the past few years, the Nuclear AMRC's machining researchers have investigated supercritical carbon dioxide as an alternative coolant, alone or in combination with a minimum quantity of lubricant (MQL).

A supercritical fluid combines the physical properties of both a liquid and a gas. That makes it extremely efficient for carrying away heat from the cutting zone, and also dense enough to carry away swarf in deep-hole drilling.

Minimising oil-based coolant also improves component cleanliness, an important consideration for safety-critical nuclear components, while reducing health risks to machine operators and environmental risks from used oil.

The new year-long project, called Process Improvement Through CO_2 Cooling (PITCO2C), will develop the technology to take it closer to production for 316L stainless steel, and demonstrate its benefits for the production of fuel assembly components.

"As a key supplier to the UK fleet of advanced gas-cooled reactors, and with over 50 years experience manufacturing for the nuclear sector, we are committed to remaining at the forefront of manufacturing technology," said David Greenan, sales director for NEC.

Process improvements: the prototype system will be retrofitted to NEC's existing machine tools.

"Using supercritical CO_2 as a cutting lubricant offers us the opportunity to increase productivity while greatly reducing the environmental impact of our manufacturing process. Not using a traditional flood coolant also means the products we produce need less cleaning, and reduces any potential detrimental health impacts on our staff."

The project builds on previous projects led by the Nuclear AMRC, with early research funded by the High Value Manufacturing Catapult. The technology was further developed as part of the Inform project funded by the first phase of the Nuclear Innovation Programme, which demonstrated that supercritical CO_2 and MQL can significantly improve machining performance and increase tool life, with no detriment to the material properties of the machined alloy.

"Each R&D project get us one step closer to providing the UK with a competitive advantage in the nuclear industry," commented Dr Krystian Wika, technical fellow at the Nuclear AMRC. "One of the major benefits for industry of supercritical CO_2 is that, compared with other advanced cooling methods such as liquid nitrogen, the technology is relatively easy to retrofit on the machine tools which manufacturers are already using."

NEC will work with the Nuclear AMRC to develop a rotary gas connector for retrofitting a CO_2 coolant unit to legacy machine tools, removing barriers to adoption for the supply chain. The prototype connector will be tested on one of NEC's large-scale milling machines, and at TSP Engineering in Cumbria.

The Nuclear AMRC team will also work with NEC to model the financial impact of adopting supercritical CO_2 in place of traditional coolants. By optimising the cutting parameters for tool life and productivity, machining costs could potentially be cut by half.

"It is vitally important, not just for us but also for UK manufacturing as a whole, that we increase our competitiveness in a global marketplace," Greenan said. "If we can achieve this alongside reducing health risks and minimising our environmental impact, then the benefits would be huge."

www.nec-ltd.co.uk

Clean future for coolants

Carl Hitchens and Dr Krystian Wika of the Nuclear AMRC machining technologies group take a closer look at the benefits of alternative coolants such as supercritical carbon dioxide.

A few years ago, we were investigating the post-manufacture cleaning processes used to prepare components for nuclear applications, and noted the significant added cost of meeting the stringent standards.

For components which need a very high level of surface cleanliness, the additional costs of removing residual oils can be as high as 20 per cent of the total component cost.

We started to think – why post-clean? Can we not improve the cleanliness of the manufacturing process?

Most surface contamination is due to the cutting fluids used in machining. These fluids are an expensive part of the machining process. You pay for the fluids and management, including biocide to prevent bacterial growth; pay to dispose of the used coolant; and pay to clean their residue off the surface of the component.

At the same time, we were starting to investigate the use of supercritical and near-cryogenic carbon dioxide (CO_2) as a machining coolant. Although our primary aim was to improve cleanliness, we also achieved significant increases in tool life compared with conventional oil coolant. This can reduce tooling costs, giving you greater scope to increase removal rates and productivity at an optimised cost.

This is a fantastic opportunity for large machine tools, where dry cutting is often used because oil coolants can't be easily contained. Gas coolants and minimum quantity lubrication (MQL) could be a real productivity boost, increasing cost efficiency, reducing waste, and making machining processes more future-friendly.

The same technique can also enable portable robotic machining, avoiding the hazards of uncontained liquid coolants and providing a clean working environment.

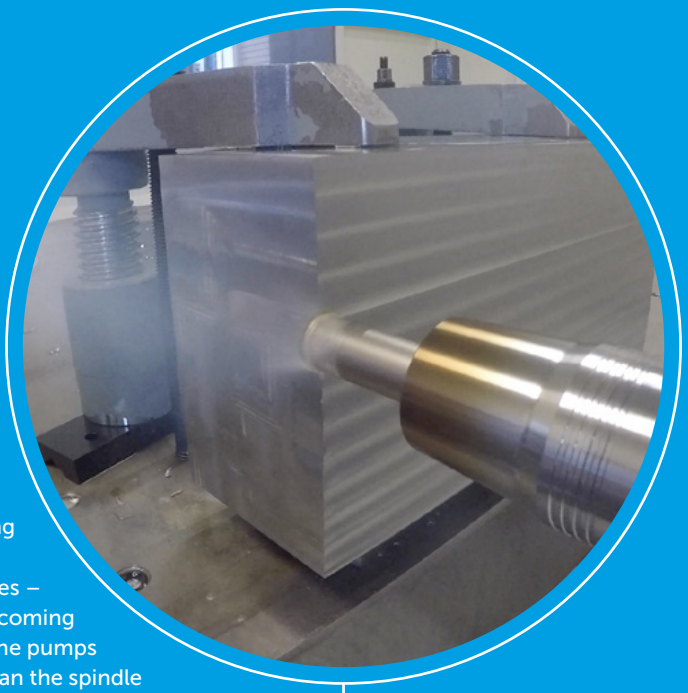
Alternative coolant technologies can benefit many traditional machining operations. Advances in soluble oil coolants have delivered some major leaps in performance, but cutting fluids can now account for 15 per cent or more of total machining costs. And with the trend to higher coolant pressures – with 120 bar or higher becoming increasingly common – the pumps often use more energy than the spindle motor doing the actual cutting.

Exposure to these oils and the mist resulting from high pressure delivery present health risks to the workforce, including skin disorders such as dermatitis, and respiratory diseases due to inhalation. Some additives are considered to be carcinogenic. If properly calculated, these health risks would further increase the financial cost of coolants.

Our research into gas coolants has focused on CO_2 because, although other gases such as nitrogen can provide lower temperatures, the heat transfer properties of CO_2 are significantly greater.

It is also technically easier to retrofit CO_2 delivery systems to standard machine tools, as the coolant is transferred through the machine tool as a liquid at ambient temperatures. This reduces barriers to entry for the supply chain, which is a major driver for our current collaboration with Nuclear Energy Components (see previous page).

People often ask about the environmental costs of using CO_2, which is of course a greenhouse gas. The gas used has been captured as a by-product of some other industrial process, and the coolant system uses a fairly small amount – typically a few hundred grams per minute during machining, similar to a car's emissions, but that's in place of tens of litres of oil per minute used in conventional systems.



Cool benefits: milling trials with supercritical CO_2 coolant.

We have investigated the total environmental impact of CO_2 coolant, and it does provide a significant net benefit over traditional techniques.

We're also exploring alternatives to conventional oil for MQL. We expect to see increasing use of biodegradable vegetable oil, either by dispersing a small amount in pressurised air, or using supercritical CO_2 as a solvent.

Creating a clean machining environment can reduce costs by avoiding environmentally harmful cleaning, and can increase quality and reduce risk to subsequent processes, such as welding where surface contamination is a frequent root cause of failure.

The clean environment will also support digital manufacturing, by making it easier to use sensors for collecting real-time production, cost, and quality data. As well as improving productivity, this can provide data for digital twins to support through-life servicing and life extension.

For more information about advanced coolant research, contact Dr Krystian Wika: k.wika@namrc.co.uk

Research office to tackle challenges of **geological disposal**

The Nuclear AMRC is part of a new research venture to support the long-term disposal of nuclear waste.

The new Radioactive Waste Management Research Support Office (RWM RSO) is a £2.5 million collaboration between the University of Sheffield and The University of Manchester. It is funded by RWM Ltd, part of the Nuclear Decommissioning Authority (NDA).

The RSO will support the delivery of independent evidence-based research to underpin the development of a UK Geological Disposal Facility (GDF). It will form the hub of an academic community across the UK, and focus on developing research to underpin the safe geological disposal of the UK's higher activity radioactive wastes.

Research will cover nine themes: advanced manufacturing, applied mathematics, applied social science, environmental science, geoscience, materials science, public communication of science, radiochemistry, and training.

The advanced manufacturing programme is led by Professor Steve Jones, CTO of the Nuclear AMRC.

"Advanced manufacturing research is key to building sustainable waste management systems," said Jones. "Manufacturing research supported by the RSO will focus on developing cost-effective fabrication and construction techniques, as well as product standardisation and process automation to enhance product integrity and performance."

Research will be driven by RWM's needs as it develops its plans for the GDF, the location of which is still to be decided. Copeland Council in Cumbria voted in July to open up discussions about hosting the facility, but identifying a suitable location with a supportive community is likely to be a long process.

The RSO will cover applied social science research to explore the societal and socio-economic aspects of geological disposal, including how public trust and confidence can be developed and sustained with potential host communities.

"Through the RSO, we will harness the best research expertise across the UK to build the knowledge and understanding required to underpin the safety case to deliver a GDF that deals permanently with the UK's higher-activity waste," said Lucy Bailey, who is heading the collaboration for RWM.

University researchers from across the UK will be invited to bid to undertake research within the nine themes. RWM expects to provide around £20 million of funding over the next decade, with potential for additional funding from relevant research councils.

The RSO will also look to extend the core team by appointing discipline leads in applied mathematics, environmental science and public communication of science, and add additional representatives from other UK universities through dedicated calls over the coming months.

www.research-support-office-gdf.ac.uk

£25m for decommissioning R&D

The NDA has announced £25 million worth of framework contracts to develop innovative approaches for tackling the challenges of decommissioning.

The Direct Research Portfolio (DRP) contracts are shared by a series of consortiums involving companies, universities and national laboratories, and will cover projects over four years. The winning groups will bid for projects as the NDA and its site licence companies identify the need for targeted research.

The University of Sheffield, including the Nuclear AMRC, is part of three consortiums covering integrated waste management and site decommissioning led by DBD, Galson Sciences and NSG Environmental; as well as three covering spent fuels and nuclear materials led by DBD, Jacobs and Orano.

The NDA and its site licence companies typically invest more than £85 million in R&D every year.

nda.gov.uk

Smart sensors
for long-term waste storage

The Nuclear AMRC has led a project for Sellafield Ltd to develop new smart technologies to monitor the condition of waste containers in long-term storage.

The research focused on innovative sensors which can help ensure the long-term safety of waste from the earliest years of the UK nuclear programme. The proposed sensor system will provide data on the condition of the waste over decades of storage.

Sellafield Ltd produces many thousands of containers of nuclear packages which require interim storage on the Sellafield site until a Geological Disposal Facility (GDF) is available. Throughout this storage period, Sellafield must demonstrate that the waste, the container and the store are evolving as expected, ideally with in situ monitoring over decades of storage.

Different kinds of waste require different kinds of container, with each type requiring a different set of key parameters to be monitored. In all cases, the sensors and any other electronic devices will need to operate for decades within a hazardous environment. They need a power supply which can also last for decades without human intervention. And they need to be able to securely transmit their data.

To tackle the challenges, Sellafield brought in the Nuclear AMRC's digital controls and instrumentation (C&I) group based at Nuclear AMRC Midlands in Derby.

In the first phase, the team reviewed and tested a variety of commercially available low-power components to identify which could best meet the requirements, then used these off-the-shelf components to build and test initial prototype systems.

The team also identified several energy harvesting techniques which can be integrated with conventional power sources. Initial proof-of-concept tests showed that the proposed method is capable of harvesting enough ambient radiation to power a sensor over several weeks of operation.

"The challenge was to develop technologies to monitor asset health in a hazardous environment, on the assumption of no main power or battery supply, and no communication cables," said Dr Li Li, head of the Nuclear AMRC's C&I team. "With a combination of in-house hardware development and commercial off-the-shelf electronics, we were able to down-select the best techniques to meet the customer's requirements and expectations for this first stage of research."

Box store: waste containers need to be monitored over decades of storage.

To bring a full range of expertise to bear on the challenge, the Nuclear AMRC called on the specialist capabilities of other High Value Manufacturing Catapult centres and academic researchers.

The Centre for Process Innovation (CPI) studied potential solutions for the energy harvesting system, and developed a prototype to demonstrate the technology. The University of Bristol also contributed to the energy harvesting research.

Digital engineering specialists from the University of Sheffield AMRC developed wireless transmission and communication techniques which can securely carry data.

"This is an ambitious project," commented Stephen Hepworth, technical lead for Sellafield Ltd. "We are continually seeking better ways to undertake our business through the novel application of technology. This project was designed to challenge our baseline approach and to demonstrate an early-stage concept. The impact has been to waken interest across the Sellafield business, and to turn a concept in a real business proposition."

Proposed future work will involve producing a full prototype for further testing and validation, with protective shielding and miniaturisation of the whole integrated system. The prototypes will be tested in a simulated radiation environment at a UK test facility, to understand the mechanistic effects of gamma radiation on the electronics.

"Although we have validated the technologies developed in the lab environment, we need to go through the irradiation test and hardness design in the next stage to ensure the robustness of the prototypes," Li said. "These sensors need to survive the extreme conditions of radioactive material storage for the long term."

Research highlights

Recent publications by Nuclear AMRC researchers.

Supply chain capabilities for AMRs

Government-sponsored research has identified opportunities to develop the UK's nuclear supply chain to make sure it has the capabilities to manufacture new designs of advanced modular reactor (AMR).

Following a techno-economic assessment of small modular reactors published in 2017, BEIS commissioned NNL and the Nuclear AMRC to assess the strengths of the UK's supply chain and R&D capabilities for design, manufacture and deployment of the different families of AMR technologies.

The Nuclear AMRC's Tauseef Syed and Matthew Wilkinson led the supply chain assessment, which identified a range of development needs which must be filled before the UK can deploy domestically-produced AMRs.

Based on analysis of the requirements of different classes of AMR, the team found that the UK's current supply chain could produce only a minority of components. The capability gaps varied between between reactor types, but common gaps included large pressure vessel fabrication, and modular assembly.

The team identified opportunities to develop the supply chain's capabilities in areas including advanced digital instrumentation and control systems, fuels, advanced manufacturing and materials. Creating a modular assembly facility could benefit all AMR designs and give the UK supply chain a global competitive advantage.

www.gov.uk/government/publications/uk-rd-and-supply-chain-capability-for-advanced-modular-reactors

Ultrasonic inspection for safety-critical pipes

An ultrasonic inspection technique used for metal pipework can also be a low-cost way to continually monitor the health of thermoplastic pipes in safety-critical applications.

High density polyethylene (HDPE) pipes are used to transport gas, water and chemicals, and could replace steel pipes for some applications in nuclear power stations and other safety-critical plant. Unfortunately the pipes can degrade over time, particularly in hot environments, potentially leading to catastrophic failure.

Ultrasonic guided waves are an accepted inspection tool for metallic structures, but are relatively untested in other materials. The technique uses an array of flexible piezoelectric transducers to capture real-time data from induced ultrasonic waves, with any defects in the structure showing up as a distinct signal.

The Nuclear AMRC's ultrasonic inspection specialist Shehan Lowe worked with researchers from Brunel Innovation Centre and the University of Surrey to investigate whether the technique works on HDPE pipes.

In research published in the journal *Sensors*, the team successfully proved the concept, and identified an optimal frequency range and other key parameters. Further research will focus on characterising specific defects, and miniaturising the prototype system for industrial use.

doi:10.3390/s20113184

Sizing up SMR modules

Prize-winning research for the UK SMR consortium will help to ensure that all parts of the modular power plant can be safely transported to site by road.

The project was led by Rolls-Royce research engineer Paul Wrigley, as part of his doctoral studies jointly supervised by the Nuclear AMRC's Professor Richard Hall.

Modular manufacturing involves the off-site assembly of large-scale complex systems, which are then transported to site for final installation. It can deliver significant improvements in cost and schedule, but poses extra design challenges.

To be transported by road without special permits, modules must fit within a maximum size envelope which depends on site location.

As the UK SMR design is still being developed, the researchers scaled down equipment data from a larger Westinghouse design which uses similar PWR technology. They found that all scaled-down components could fit within the maximum road transport envelope, and identified several vessels which were close to the limit and would need to be redesigned to fit a smaller module envelope.

The research will inform the final design of the UK SMR, with the team developing a preliminary layout optimisation model to ensure all modules fit within a standard envelope. The optimisation model will rapidly assess millions of potential layouts for a module, and produce a digital model for further development by design engineers.

Wrigley presented the research at the 28th International Conference on Nuclear Engineering in August, where it was awarded the prize for best European student paper. The full paper will be published in the conference proceedings.

event.asme.org/ICONE

New capabilities in **plasma welding**

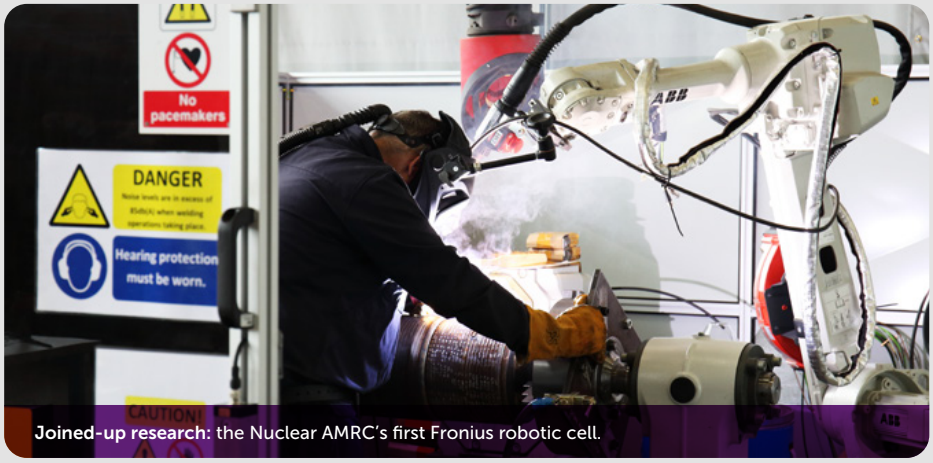
A new robotic cell gives the Nuclear AMRC new capabilities in automated plasma welding for challenging fabrications.

Plasma welding is similar to the well-established gas tungsten arc welding (GTAW) process used for many applications in the nuclear sector. The difference is that plasma welding uses a cooled gas nozzle to produce a concentrated high-energy arc which can create a much deeper weld without the risk of part distortion.

The technique offers welding speeds up to 20 per cent faster than conventional GTAW, with up to 30 per cent less filler material and no weld-seam preparation.

The new cell is based around a Fronius MagicWave and PlasmaModule system linked to a choice of specialised welding torches mounted on a 1.85 metre robot arm. It is also capable of high-quality conventional GTAW work.

The securely shielded cell also includes a twin-axis positioning table capable of holding parts up to 750kg, and other advanced features including calibration and alignment tools.



Joined-up research: the Nuclear AMRC's first Fronius robotic cell.

After the cell is commissioned in September, the Nuclear AMRC arc welding team will put the equipment through its paces to better understand its capabilities for applications such as waste container fabrication and additive manufacturing. Ongoing research will establish key process variables for high-quality joins in carbon steel.

The cell sits alongside another robotic welding cell installed in 2019 which uses Fronius's cold metal transfer technology. This is an advanced form of gas metal arc welding (GMAW) which can join and clad a range of steels with much lower heat input than conventional methods.

www.fronius.com/en

Successful finish for **flawed welds**

The Nuclear AMRC arc welding team are celebrating the successful completion of the most challenging fabrications in an ongoing collaboration with NDT specialist Sonaspection.

The centre has worked with Sonaspection and Jacobs to produce a series of intentionally flawed test pieces which will help ensure the quality of welded components for Hinkley Point C.

Sonaspection, part of the Institution of Mechanical Engineers, is the UK's longest-established manufacturer of flawed test pieces in the non-destructive testing (NDT) industry. The company was contracted to produce a series of test pieces by Jacobs, whose Inspection Validation Centre (IVC) is the independent qualification body for EDF Energy's Hinkley Point C project.

The Nuclear AMRC has now helped complete a series of test pieces and components of increasing complexity. The largest piece was a large ring assembly representing a section of a pressuriser for the UK-EPR reactor. Around four metres in diameter, the assembly includes two internal structures featuring nozzle-to-shell welds with implanted flaws.

The Nuclear AMRC team clad the structures using two mechanised techniques, submerged arc strip cladding and gas tungsten arc cladding, using equipment provided by member companies WB Alloys and Polysoude.

"We searched all over UK and Europe to try and find a supplier who would be able to perform the cladding welds on these two test pieces but had no luck at all," says Max Yates, group operations manager for Sonaspection.

"Thanks to the outside-of-the-box thinking to get around the issue of them being part sections and the skilled welding workforce at Nuclear AMRC, we have achieved fantastic results. Without the ongoing working relationship between Sonaspection and Nuclear AMRC, these blocks would never have happened."

The test pieces will be used as part of the overall assessment of the NDT system for Hinkley Point C in practical procedure and personnel qualification trials.

sonaspection.com

New collaboration to boost **clean energy in North Wales**

A new partnership between the Nuclear AMRC and M-SParc will help support clean energy innovation in North Wales.

Low-carbon hub: Menai Science Park.

The Menai Science Park (M-SParc) on the Isle of Anglesey is part of Bangor University, with the mission of developing the region's knowledge-based economy. Bangor University is also home to the Nuclear Futures Institute (NFI), which aims to help North Wales become a global centre in nuclear technology.

By joining the Nuclear AMRC as a tier two member, M-SParc will foster collaboration between the centre and researchers at Bangor, covering commercial and collaborative R&D projects into nuclear materials, controls and instrumentation, digital technology and modularisation.

Pryderi ap Rhisiart, M-SParc's managing director, sees the collaboration as a step forward for SMEs in the region. "This new collaboration should yield opportunities for our eco-system of innovative businesses in the nuclear sector and I look forward to seeing them engage with the Nuclear AMRC," he said.

"M-SParc's focus is on low carbon energy, the environment, ICT and natural products, and so this collaboration is beneficial not only from an engineering perspective but on other aspects such as digital technology into the future. This enhances the collaboration further, bringing new opportunities for current and potential future tenants of M-SParc, and SMEs in the region, to benefit from the nuclear cluster."

As part of its membership, M-SParc is providing office space for the Nuclear AMRC, giving the centre a regional base to engage with businesses in North Wales and support future development on the region's licenced nuclear sites. The Nuclear AMRC has already worked with dozens of Welsh manufacturers through its Fit For Nuclear supplier development programme, with support from the Welsh government.

"This helps cement the relationship between the Nuclear AMRC and the nuclear cluster around Bangor, in one of the UK's most strategically important nuclear regions," said Professor Richard Hall, regional director for the Nuclear AMRC. "Bangor University has growing R&D capabilities for nuclear, and we're already collaborating on a number of major projects to support clean energy in North Wales."

The Nuclear Future Institute focuses on materials for nuclear and extreme environments, thermal hydraulics and reactor design.

"Working with the Nuclear AMRC gives the NFI instant links with many companies and institutions working in the nuclear sector," said Professor Bill Lee, NFI director. "In particular, there are opportunities to collaborate with world-leading researchers on new reactors such as small modular reactors, advanced modular reactors, and small spherical tokamaks, and the application of new thermal hydraulic, digital, AI and robotic technologies to these reactors."

Menai Science Park: **www.m-sparc.com**

Nuclear Futures Institute: **nubu.nu**

Executive **view**

Why we need **whole system thinking**

This year has been an education in crisis management. We've all had to change the way we live our lives at home and at work. The response to the coronavirus has shown us the dedication of frontline workers, and the ingenuity of those who stepped forward to help close the gaps in PPE and medical equipment, bringing the work of medical research and science to the forefront of our minds.

However, Covid-19 isn't the only crisis we need to deal with. The battle against climate change still needs to be addressed, and the UK committing to net zero emissions by 2050 is not going to deliver a change: that simply sets a goal.

Net zero is a massive challenge, and there's been a lot of talk but little meaningful action since it was made a legal commitment in 2019. Action is needed to decide which technologies we develop and deploy to create the power we need to survive and thrive. This requires us to consider the entire complex system of energy and the economy, and apply innovation in every area.

In recent months, reports from the Energy Systems Catapult, Atkins, the government's Committee on Climate Change and others have all plotted potential pathways to net zero. Crucially, all highlight the opportunity to drive a national economic renewal by investing in new low-carbon technologies, produced by UK manufacturers and backed by world-leading R&D.

Industry and the research base are ready to act, but we need government to take the lead in deciding the path the UK takes.

At the start of the year, the Prime Minister's advisory Council for Science and Technology submitted a detailed report* on how government could use "a disciplined and rigorous whole systems approach" to achieve net zero.

A whole systems approach is based on a managed process to understand the complex challenges posed by the net-zero commitment, and to devise and deploy the solutions and innovations that are most likely to succeed.

The Council argues that investment in R&D will be an essential part of this. Investment needs to tackle three tracks – discovery, development and deployment – with the greatest emphasis on removing the barriers to deployment for market-ready technologies, and accelerating those at an advanced stage of development.

In energy, that has to mean investment in new nuclear – the only proven low-carbon generation capable of providing always-on baseload power to balance the variability of wind and other renewables. Nuclear currently makes up 40 per cent of our low-carbon generation, and keeping that share makes engineering and economic sense.

As the Council noted, achieving net zero will require very strong and effective leadership from government, as well as innovative approaches to policy making and delivery in all regions of the UK.

Boris Johnson has signalled his backing for a whole systems approach, and hopefully this will be articulated in the long-overdue Energy White Paper.

Thinking about the whole system also shows how nuclear power can play a much more varied role in the low-carbon economy, with opportunities in industrial cogeneration, municipal district heating and hydrogen production.

We believe the best way of reducing emissions before 2050 is with a mix of gigawatt-scale reactors and small/advanced modular reactors. Our centre is part of the UK SMR consortium, and we are working with other developers to turn their designs into engineered reality.

We're also working with the developers of a host of advanced reactors, including compact flexible fission reactors and the first commercial fusion reactors. Whether these are producing power before 2050 will again depend on UK strategy and the maturity of technology.

We're working closely with UKAEA on materials and manufacturing for fusion power, and looking forward to the opening of their Yorkshire facility this winter (see p26). The success of the Advanced Manufacturing Park has shown the impact of clustering innovative R&D capabilities with industrial knowhow – a model for local regeneration and economic recovery which we're now replicating with our new centre in Derby.

We recognise that Nuclear AMRC is a very small part of the machinery needed to tackle the fight against climate change but, if all the small parts are brought together around an agreed plan of attack, I remain confident that the UK can deliver its net zero commitment and be a leader for the rest of the world.

I hope we can establish a plan soon and put all our efforts to this, which will also go a long way to address the Covid-19 recovery and stimulate economic growth.

Andrew Storer, CEO, Nuclear AMRC

*** www.gov.uk/government/publications/achieving-net-zero-carbon-emissions-through-a-whole-systems-approach**

Managing a safe return to work

Every organisation has faced a host of challenges since the Covid-19 pandemic hit the UK in early spring. For the Nuclear AMRC, it meant taking swift action to protect staff, then managing a careful return to operations to meet the needs of its customers – while continuing to support the supply chain and playing a role in vital national initiatives.

The centre suspended all workshop operations to protect staff health, following the national lockdown in late March. All 145 members of staff continued to work safely from home while a core team led by programme director Jay Shaw carried out risk assessments and drew up a five-phase plan for returning to work while keeping staff safety as the number one priority.

In the fourth phase, beginning in late June, the Nuclear AMRC returned its research factory in Rotherham to full capacity. Work resumed on all the R&D projects suspended in March to meet the requirements of its industrial customers and stakeholders. Staff continued to work from home where possible.

"As we continue to successfully move through the phases of our plan, we are able to safely bring more shopfloor-based projects back online," Shaw noted. "This is testament to the hard work, diligence and professionalism of everyone involved."

All Nuclear AMRC staff worked from home throughout early summer, focusing on desk-based research and business support initiatives, and supporting national initiatives including the VentilatorChallengeUK consortium led by the High Value Manufacturing Catapult (see p26).

The team advised more than 130 companies from the nuclear supply chain and local networks on design, manufacturing techniques and specifications for ventilator and PPE supplies, connecting businesses with local NHS trusts and national programmes where they can contribute their skills and capabilities.

In early June, Shaw led a webinar for members and Fit For Nuclear (F4N) companies to discuss best practice in managing a safe return to work. The F4N team also produced a widely-shared guide to how the nuclear industry's established safety culture could provide a model for businesses in other sectors (see over).

"Many of our stakeholders have said how impressed they are with the professional approach of our centre, and it has been held up as an example of best practice for industry and the rest of the University of

Sheffield," Shaw said.

The phased return to work was based on rigorous risk assessments, drawing on best practice from the centre's network of manufacturers and other nuclear organisations.

In the first phase, beginning in May, a skeleton team implemented new safeguards to allow work to resume a small number of key research projects in the second phase.

Measures included markings to help people maintain safe distancing from the car park to the shopfloor, a one-way flow system around the building, hands-free door openers, protective shields in reception, and hand-sanitising stations throughout the facility.

All staff were issued with the overarching risk assessment, training and details of work practices to maintain distancing, cleaning and personal hygiene. For each project, the team reviewed risk assessments and methods statements to make sure that safe distancing and hygiene can be maintained. If distancing is impracticable, a full range of control measures were put in place to minimise risk to staff.

The Nuclear AMRC regional teams in Derby and Birkenhead followed the same process, with support from local stakeholders.

The centre started to admit visitors in August, with additional risk assessments and precautions to protect both visitors and staff. Science minister Amanda Solloway was the first to visit (see p2).

From September, all staff will be invited to return to the centre on a rota basis, with a different group of people allowed in each week to gradually resume regular working patterns.

"This will help safeguard the mental health of our colleagues as they return to normal work after months of home working, and allow us to increase productivity across our operations," Shaw noted.

The final phase, with all staff returning full-time to the facilities, will be implemented only when the government lifts all work and travel restrictions.

The daily grind: safety measures are part of everyday life in nuclear manufacturing.

Safety culture doesn't happen by accident

The Covid pandemic turned every workplace into a hazardous environment. As more businesses adapt to operating under very different working conditions, the nuclear industry's established safety culture could provide a model for other sectors.

Nuclear AMRC industrial advisor Huw Jenkins introduces the essential attitudes and behaviours for safe working

The VE day anniversary in May reminded us how the British can be at their best in adversity, working together to defeat a common foe. In the continuing Covid-19 crisis, we can be proud of the selflessness of our health and care workers, and the kind acts of volunteers helping out those less fortunate.

The British instinctively dislike being told what to do, being generally more amenable to reasoned polite request. "Policing by consent" has been the basis of our approach since the 19th century, and there's been widespread opprobrium for heavy-handed applications of lockdown law by some officers.

The public also gives short shrift to figures of authority setting a "do as I say, not as I do" example, as several politicians and advisors have been reminded.

So you'd expect British workers to embrace a culture that works by consent – a culture that is characterised by leaders setting an example, and individuals accepting personal responsibility.

That is the basis of nuclear safety culture.

This safety culture applies to every business working in the nuclear supply chain, not just those managing radioactive or fissile materials. Any seemingly minor quality issue in the supply chain has the potential to become a safety problem for an operating reactor or waste store, maybe decades into the future.

Many of the companies we help through the Fit For Nuclear programme say that upgrading their safety culture is one of the most valuable improvements they make, bringing business benefits that go well beyond their work for the nuclear sector.

Nuclear safety culture has eight internationally recognised characteristics, which I've listed below, along with some questions to ask about how they can be applied within a business. Not all will be applicable to every sector, but the essential attitudes and behaviours can help save lives in manufacturing, construction and beyond.

Ultimately, the key to safety culture is shared responsibility. While it's always the legal responsibility of the employer to provide a safe working environment, including all necessary PPE, everyone from the boardroom to the shopfloor needs to take personal responsibility for protecting the health and safety of themselves and their colleagues.

How well does your company culture match up?

1 Everyone is personally responsible for safety.

- Do all individual employees actively participate in pre-job briefings? Do they understand the objective of the work they do, and their role in achieving it safely?
- Are staff open to performance feedback?
- Do they observe and coach colleagues, especially when behaviours fall short of expected standards?
- Is everyone committed to improving themselves, the way they work and the working environment?

2 Leaders demonstrate their commitment to safety.

- Do the senior leadership team communicate frequently, through a variety of channels, to reinforce the understanding that safety is the business's overriding priority?
- Are senior managers leading advocates of safety, demonstrating commitment in both word and action? Do they walk the talk when resolving safety or quality issues that appear in conflict with production requirements?
- Do they encourage individual employees to challenge unsafe behaviour and conditions?
- Do they support those who stop operational activities for safety reasons?

3 Trust permeates the organisation.

- Does the business regard its employees, and their professional capability and experience, as its most valuable asset?
- Is everyone treated with dignity and respect?
- Do leaders respond to questions openly, sharing important information in an open, honest and timely manner?
- Does everyone treat decision-makers with respect, even if they might disagree?

4 Decision-making reflects the safety-first approach.

- Is safety-related decision-making systematic, rigorous and thorough? Is it delegated to the correct individual at the lowest appropriate level?
- Do individuals understand expectations to place plant, equipment and work in a safe condition, when faced with unplanned or uncertain conditions?

5 Nuclear technology is recognised as special and unique.

(This one is really only for companies in the nuclear supply chain, although every business should understand the specific requirements of the industry they work in.)

- Are the special characteristics of nuclear technology understood and taken into account?
- Is work on safety-critical equipment or components for nuclear plant identified as such?

6 A questioning attitude is cultivated.

- Do leaders question assumptions, decisions and risk assessments that don't appear to be sufficiently rigorous?
- Do they ensure specific contingency actions are discussed and understood during pre-job briefings?
- Do individual employees challenge assumptions and guidance, and offer opposing views when they think something isn't correct?
- Do they have the integrity and confidence of leadership support to stop work when assumptions and guidance cannot be validated?

7 Organisational learning is embraced.

- Are opportunities to learn sought out and implemented? Do these routinely include ways of ensuring safety?
- Do you conduct objective, self-critical reviews and assessments of your work processes and procedures?
- Are there processes in place to learn from other organisations, and so continuously improve knowledge, skills and safety performance?

8 Safety undergoes constant examination.

- Does the senior leadership team use a variety of monitoring tools to regularly monitor the business's safety culture?
- Do these include feedback from employee surveys, external independent assessment/audits or internal review/audits?

F4N
Fit For Nuclear

Fibre protection: Heatsense's cables are made for extreme environments.

Fit For Nuclear helps Heatsense **hurdle barriers to entry**

Heatsense Cables is winning new customers after becoming the first specialist cable manufacturer to be granted Fit For Nuclear status.

Based in Rochdale, Greater Manchester, Heatsense is the UK's leading manufacturer of high-performance thermocouple and signal cables for extreme environments.

The firm specialises in cables which are resistant to flame, oils and chemicals, and operate in ultra-high vacuum, cryogenic and high radiation environments for customers in nuclear, aerospace, medical and other sectors. Products range from single wires to multicore cables, braided in glass or ceramic fibres, other specialist yarns or metals.

Founded in 1984, the business was acquired in 2014 by a new management team led by director Jeremy Kemsley-Pein.

"We saw an opportunity to build the company into a specialist high-performance cable business," Kemsley-Pein recalls. "A clear objective from day one was to ensure that there were no barriers to doing business with Heatsense. Step one was to ensure that the company had all the relevant quality and environmental accreditations that are now considered essential by corporates."

The new team quickly achieved the latest ISO9001 quality management and ISO14001 environmental management certification, and looked for other ways to reduce barriers to new markets.

"At the time, there was a great deal of talk regarding developments and opportunities in the nuclear industry," says Kemsley-Pein. "We took the view that there would be opportunities, and that F4N approval would reduce barriers to entering the industry. No other cable company had been awarded F4N status, as is still the case today."

Adopting lean: inside Heatsense's Rochdale factory.

The assessment highlighted the importance of health and safety culture to nuclear customer expectations. "Part of the journey involved sending key staff members on a nuclear awareness course, and this knowledge, awareness and understanding was embedded back into the business," Kemsley-Pein says. "Another key factor was the importance of regular communication with all staff members. It is easy to assume that all staff know what is going in an SME, but that is not necessarily the case."

Lean manufacturing was another area for development, with Nuclear AMRC industrial

advisor John Olver helping the firm adopt Kaizen and 5S techniques to continually improve systems and procedures. Kemsley-Pein points to the visual presentation of key performance indicators and analysis posted on the factory walls and meeting rooms as evidence of the encouragement and guidance of the F4N team.

The F4N journey also helped Heatsense develop its digital strategy to embrace Industry 4.0 technologies, with digital processes on individual production lines allowing further improvements to efficiency, quality and throughput rates.

"The F4N journey has significantly improved the company on all fronts, and we encourage customers, prospective customers and auditors to visit as we are extremely proud of what our team has achieved over the last five years," Kemsley-Pein says.

Heatsense has continued to develop since being awarded F4N status at the start of the year, remaining fully operational throughout the Covid-19 lockdown. The firm has taken on more space, purchased additional plant and equipment, expanded its manufacturing capabilities, employed more staff, and won a number of new high-end customers.

The changes made through F4N have undoubtedly assisted in securing additional business in a range of sectors, Kemsley-Pein notes, but progress in the nuclear sphere has been slow.

"Ideally, we would work in conjunction with major contractors serving the nuclear industry and act as a tier two supplier addressing their specific cable requirements," he says. "We have found it difficult to get access to large nuclear contractors and consultants, but we hope that higher visibility through the F4N community will assist."

Heatsense's capabilities for the nuclear sector were vividly illustrated during its F4N journey, when the firm received an enquiry from a nuclear plant operator. The request was for bespoke temperature monitoring cables to operate within the extremely hazardous environment of its spent fuel storage system – a job that would usually take at least four weeks to deliver. The team agreed a technical specification within four days, and delivered the cables to site one week after the initial enquiry.

"We understood the critical nature of the production and were happy to go the extra mile," says Kemsley-Pein. "Over time, we would like to establish strong business relationships with all key nuclear contractors, and be regarded as having outstanding knowledge and design capabilities for cables that operate in extreme environments."

www.heatsensecables.co.uk

Congratulations to the latest companies to be granted Fit For Nuclear

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

Bendalls Engineering is a world-class manufacturer operating in the nuclear, oil & gas, process, pharmaceutical and petrochemical industries with capabilities to design, fabricate, machine, inspect and test in-house.
bendalls.co.uk

LTi Metaltech specialises in precision fabrication and welding for highly-regulated industries including nuclear, fusion, healthcare, renewables, transport and rail.
www.lti-metaltech.com

Site Heat-Treatment Services has 40 years' experience of specialist service in thermal engineering, covering all types of on-site electrical and gas heat treatment, as well as furnace heat treatment.
www.shs-group.com

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

- **AM Sensors**
- **Cam Machine Components**
- **NIS**
- **NTR**
- **Nuclear Energy Components**
- **Pipex**
- **Teddington Engineering Solutions**

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

F4N
Fit For Nuclear

Hardstaff aims to be **supplier of choice**

Site protection specialist Hardstaff Barriers is aiming to become the nuclear sector's supplier of choice. Service manager Kathryn Cooper explains how support from the Fit For Nuclear programme helped the company get ready for the opportunities.

Hardstaff Barriers is a multi award-winning manufacturer and supplier of protective barriers and perimeter security systems. Available as both temporary and permanent solutions, our roadside hostile vehicle mitigation (HVM) systems, perimeter fencing, concrete security barriers and access gates are designed for one reason: to keep people and property safe.

Our products are designed to offer the highest levels of protection and are delivered with expertise and excellence. As trusted experts in the industry, we also deliver the National Barrier Asset for the UK government. Our product approvals include EN 1317, IWA 14-1 and PAS68, giving protection in all transport and construction sectors including highways, aviation, nuclear and ports for protection and delineation.

Hardstaff took part in the F4N programme in an effort to become leaders in the sector of supplying and installing HVM and perimeter security solutions. Our barrier products have already provided edge protection and delineation for nuclear construction projects including Hinkley Point C.

Hardstaff has also provided HVM protection at major existing nuclear infrastructure sites, such as Sellafield. The company is passionate about safety and protecting people and property through its variety of products. We would like to be the supplier of choice in the nuclear sector.

The assessment highlighted a few ways that we can improve our processes and systems. With the help of F4N consultant Kevin Ross, we created targets and actions and closely monitored them to ensure that these were achieved within 12 months.

We introduced a staff forum, which really helped to improve communication and employee engagement. This was very helpful to the business overall.

The increased communication and employee engagement has already improved staff morale. All members of the team are excited to have achieved this status and are excited for what the future holds in the nuclear sector.

We are keen to improve security by providing a range of HVM solutions that are specific to the threat and are flexible at the same time. We have also recently acquired Fleet Operator Recognition Scheme (FORS) Gold, which we are extremely proud of. This demonstrates the company's commitment to fleet safety, efficiency and environmental protection.

We would like to be the supplier of choice for temporary and permanent perimeter security, barrier and gate systems for the nuclear industry in the UK and abroad.

Hardstaff is proud to be working in the nuclear industry, which is ultimately making a major contribution to the UK's move to reduce carbon emissions.

www.hardstaffbarriers.com

Edge protection: Hardstaff is helping keep workers safe at Hinkley Point C.

The next phase begins: Hinkley Point C in summer 2020.

F4N manufacturers win work at **Hinkley Point**

Two Fit For Nuclear companies have secured major contracts as Hinkley Point C moves into the next phase of construction.

Ventilation specialist Exyte Hargreaves and control system group Capula are now beginning work to deliver key parts of mechanical, electrical and HVAC (heating, ventilation and air conditioning) systems across the Hinkley Point C site. The overall work programme is being delivered by the MEH Alliance joint venture headed by Altrad, Balfour Beatty Bailey, Cavendish Nuclear and Doosan Babcock.

Staffordshire-based Capula was awarded a multi-million-pound contract to design and manufacture safety-classified instrumentation and control marshalling cabinets to house electronic circuitry for Hinkley Point C. The cabinets are a first of their kind to be designed and made in the UK.

"Capula brings a wealth of skills and experience in automation and system integration, which will allow our team to deliver a high-quality right-first-time system, and ensure that HPC can be safely brought online as planned in 2025, paving the way for our sister project at Sizewell C," said Glenn Lee, electrical project manager for Hinkley Point C.

Capula was granted F4N status in summer 2019, after entering the programme to support its ambition of being the supplier of choice to the nuclear industry.

It will now create up to 50 new engineering roles to fulfil the contract, enhancing its design and manufacturing capabilities and investing to upgrade existing facilities. The company is also implementing a rigorous training programme to support the next generation of skilled workers to support projects across the UK and beyond.

Bury-based Exyte Hargreaves, which was first granted F4N in 2013, will design, manufacture, assemble and commission HVAC systems across the conventional non-reactor areas of Hinkley Point C.

At least a third of the plant and equipment will be manufactured in the UK, with 30 new jobs to be created at Exyte Hargreaves in project delivery, off-site assembly and site-based roles. The project will also provide new roles for apprentices in the South West, and new training and development opportunities for apprentices on the Exyte Hargreaves Engineering Young Talent Scheme.

"In this next major chapter for our project, the MEH phase will join together hundreds of small and large companies from across Britain, creating 1,200 new jobs and 300 apprenticeships," said Simon Parsons, MEH programme director for Hinkley Point C.

"Together we are delivering on our promise to build Britain's industrial capability by creating new jobs and skills. Development of a near-identical power station at Sizewell C will bring further opportunities for our extensive and experienced British supply chain."

www.capula.co.uk

www.exyte-hargreaves.net

TSP Engineering wins £30m Sellafield contract

TSP Engineering has won a £30 million contract to manufacture nuclear waste containers for Sellafield Ltd.

The West Cumbrian company will produce 50-tonne lead-lined containers for the transfer of nuclear waste from the legacy Magnox Swarf Storage Silo to new storage facilities on the Sellafield site.

The work is expected to run over several years, creating or sustaining around 200 jobs at TSP Engineering. Alongside other recent orders, the work will bring the firm's workforce to more than 250 people.

"This is great news for TSP Engineering, our workforce, supply chain and the local economy," said John Coughlan, CEO at TSP Engineering. "Sellafield placing this order highlights the confidence our nuclear customers have in our proven ability to deliver the most technical and complex solutions within budget and programme plan.

"It is a significant step towards our ambition to further grow in the nuclear industry, and highlights the calibre and skill of our award-winning workforce."

TSP Engineering is a tier one member of the Nuclear AMRC, and is currently collaborating with the centre on projects funded by the Nuclear Innovation Programme. TSP has also worked with the centre through the Fit For Nuclear and Civil Nuclear Sharing in Growth supplier development programmes.

The company has a long history of manufacturing high-integrity products for Sellafield, previously completing one new and nine refurbished packages for the Magnox Swarf Storage Silo. The new contract will complete the fleet of packages needed to empty the silo, which is one of the NDA's highest priority programmes.

"I was delighted to see a local business win this contract, which will lead to job creation and opportunities for West Cumbria," said Martin Chown, CEO of Sellafield Ltd. "TSP Engineering is a world-class company. Its success in winning this contract proves our nuclear supply chain can compete with the best in the world."

www.tsp-engineering.co.uk

First companies granted Fit 4 Offshore Renewables

F4OR
Fit For Offshore Renewables

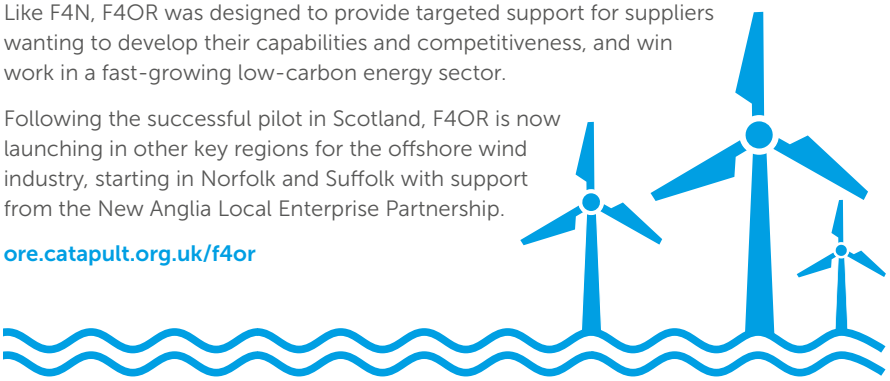
Three Scottish manufacturers are the first to be granted F4OR status under a new supply chain programme based on the proven Fit For Nuclear model.

Fit 4 Offshore Renewables (F4OR) is a collaboration between the Offshore Renewable Energy Catapult and the Nuclear AMRC, with the pilot programme supported by the Scottish government.

Like F4N, F4OR was designed to provide targeted support for suppliers wanting to develop their capabilities and competitiveness, and win work in a fast-growing low-carbon energy sector.

Following the successful pilot in Scotland, F4OR is now launching in other key regions for the offshore wind industry, starting in Norfolk and Suffolk with support from the New Anglia Local Enterprise Partnership.

ore.catapult.org.uk/f4or



Congratulations to the first F4OR companies:

Balmoral provides high-tech buoyancy, protection and insulation products for offshore wind installations, as well as specialist products for the defence and oil & gas sectors.
www.balmoraloffshore.com

Leask Marine provides vessel charter, commercial diving and international marine construction services, and has completed projects for leading marine energy converters.
www.leaskmarine.com

Peritus International provides subsea system and offshore pipeline engineering services to the offshore energy industry.
www.peritusint.com

Codra signs up for **digital innovation**

Industrial software specialist Codra has joined the Nuclear AMRC to help develop new digital engineering tools for manufacturers and operators of critical national infrastructure.

Manchester-based Codra Software Ltd, the UK division of the Paris-based Codra group, has joined the Nuclear AMRC as a tier two member.

Codra specialises in industrial supervisory control and data acquisition (SCADA) software, which collects, models and analyses operational data from plant and facilities to support continuous improvement. Codra's Panorama suite is used by more than 1,000 blue-chip clients worldwide, with several major customers in the UK nuclear sector including EDF Energy.

Codra is working closely with the Nuclear AMRC's digital engineering team to help smaller businesses integrate systems and data in innovative ways, and to develop new applications based on the Panorama platform.

Based at the Nuclear AMRC Midlands facility in Derby, the digital environment group work with manufacturers of all sizes to improve performance through digitalised design, analysis, training, validation and production scheduling. The team draw on a wide range of software and hardware technologies, developing new applications to meet industry needs.

"We're delighted to welcome Codra as a member of the Nuclear AMRC," said Dr Stephen Marr, head of the digital environment group. "Codra offers a powerful software platform for management functions such as production control and facilities management, which is scalable from small applications with around 100 variables, to much larger and more complex requirements with millions of variables."

As part of its tier two membership, Codra will provide its Panorama suite platform to the Nuclear AMRC, along with support, training and innovative design ideas.

This collaboration will focus on using Panorama to develop data pathways for digital twins, detailed real-time replicas of operational facilities such as power plants or factories.

The Nuclear AMRC team will explore innovative ways of integrating these models with virtual and augmented reality technologies to develop new ways of visualising and understanding information from sensors across complex installations.

The team will also create technology demonstrators for companies of all sizes, to explore new applications such as condition monitoring and inspection for waste management sites, and improved data collection and analysis for predictive maintenance.

"Technology demonstrators can help manufacturers to understand how they can benefit from industrial digital technologies, and serve as a testbed for integrating different software and hardware solutions into systems that meet their requirements," Marr said.

codra.net/en

Jobs map shows **nuclear resilience**

The number of people working in the UK nuclear sector has remained steady despite the Covid-19 pandemic, according to the latest survey by the Nuclear Industry Association (NIA).

The NIA's annual jobs map shows that 59,584 people are employed in the civil nuclear sector across the UK, a slight increase on 2019.

All parts of the industry, including generation, new build, decommissioning and R&D, have sustained operations throughout the disruptions of Covid-19. Thousands of workers in the existing fleet across Scotland and England have ensured that no station has had to stop producing power because of the pandemic, and Hunterston B has been able to restart generation.

"The nuclear industry has shown extraordinary resilience in sustaining high-skilled, well-paid jobs and keeping the lights on throughout this pandemic," commented NIA chief executive Tom Greatrex. "The growth in employment on new build projects and advanced research and development shows how investing in emissions free, reliable and secure nuclear power can cut emissions and create the skilled, long-term jobs we need for a green recovery."

New build projects have played a key role in sustaining employment and improving the UK's construction skills base. Hinkley Point C employs around 4,500 people on site, and more than 600 apprentices have been trained on the project.

www.niauk.org/resources/jobs-map-2020

Future fusion: UKAEA's new facility on the Advanced Manufacturing Park.

UKAEA Yorkshire prepares to open

UKAEA is fitting out its new fusion technology facility in South Yorkshire, ahead of an official opening this winter.

Construction completed in August, with the £22 million building handed over to UKAEA in September.

The 2,500m^2 facility will develop and test technologies for fusion materials and components, including novel metals and ceramics. These will be tested and evaluated under conditions simulating the inside of a fusion reactor, including high heat flux, vacuum and extreme magnetic fields.

The facility will also help UK companies win contracts for Iter, the international fusion project being built in the south of France. Further ahead, it will enable technology development for the first commercial fusion power plants.

"We are delivering the new facility at pace, with major milestones on building mobilisation and recruitment for the new facility proceeding to plan," said Damon Johnstone, head of UKAEA Yorkshire.

"There are exciting times ahead – the fusion technology facility in Rotherham will be unique in the world and, as well as delivering cutting-edge R&D, it will help to seed the development of a UK supply chain for fusion.

"We can't wait to get going and have no doubt the hub of manufacturing excellence being created in the area will prove to be of great importance to the commercialisation of fusion power."

The facility is strategically placed to engage industry in commercial fusion development, and to work with the established engineering research cluster on and around the Advanced Manufacturing Park (AMP).

It will bring 40 initial jobs to the area, and foster increased collaboration with research organisations based on AMP including the Nuclear AMRC, University of Sheffield AMRC and TWI.

"The Sheffield City Region is a growing hub of innovation, expertise, and knowledge," commented Dan Jarvis, Mayor of the Sheffield City Region. "Building a low-carbon future is one of the most important goals we can use those strengths to achieve. As we look to rebuild and renew following the pandemic, this facility will create new skilled jobs and opportunities for collaboration with nearby research centres and other businesses as specialist suppliers, boosting the region's economy and highlighting our world-leading specialisms in advanced manufacturing."

The Nuclear AMRC's Professor Steve Jones joined Johnstone and other key partners for a webinar on the new centre, hosted by the Nuclear Industry Association in early September.

ccfe.ukaea.uk/technology/fusion-technology

NIA calls for 40 by '50

The UK needs to commit to new nuclear power stations to make a clean economic recovery and meet net-zero commitments, according to a report from the Nuclear Industry Association (NIA).

The NIA produced the report, Forty by '50: The Nuclear Roadmap, for the industry/ government Nuclear Industry Council (NIC) in June.

The NIC-endorsed report says that, in addition to helping meet long-term goals, prompt decisions on a new nuclear power programme could unlock mega-projects and deliver immediate benefits to help tackle the economic impact of Covid-19.

According to the report, an ambitious programme based on existing and new technologies could provide up to 40 per cent of clean power by 2050, and drive deeper decarbonisation. It could eventually bring as many as 300,000 jobs and £33 billion of annual economic value.

Nuclear currently contributes 40 per cent of the UK's clean electricity, but total demand is expected to quadruple from the replacement of fossil fuels and a boom in the electric vehicles and heating sectors.

The report was welcomed by Nuclear AMRC CEO Andrew Storer, a member of the NIC.

"Nuclear needs to be part of the energy mix for net zero and, as this report shows, it's a technology that can maximise the benefits for the UK economy," Storer commented. "British companies can lead the development of new technologies such as small and advanced modular reactors and fusion power, using their manufacturing expertise and innovation to reduce the cost of the low-carbon transition while driving economic growth and creating jobs in the North of England and across our industrial heartlands. We really need to push forward now to grasp the opportunity and deliver on our clean energy commitment."

Earlier in June, the International Energy Agency urged policy-makers to focus on sustainable recovery. At the same time, the Energy Systems Catapult published detailed analysis calling for at least 10GW of new nuclear capacity beyond the current new-build at Hinkley Point.

"Net zero needs nuclear, and the sector is developing fast," said NIA chief executive Tom Greatrex. "The next large-scale projects are now deliverable much more cheaply by building on repeat and tried and tested designs, capturing learnings from our new build programme, and making important changes to the way projects are financed.

"We're confident the price of nuclear power will fall from the £92.50 per megawatt hour for the first plant, closer to £60/MWh for the next wave of power stations reducing to around £40/MWh for further reactors.

"Greenlighting new projects already in the pipeline would trigger a ramp-up in investment and job creation in parts of the UK facing the biggest economic challenges, and clear the way for long term decarbonisation through the hydrogen economy, helping establish the UK nuclear sector as global leader in the field.

"Commitment to the roll-out of smaller and advanced reactors would build on that momentum. Conversely, if we do nothing, we are effectively sitting on a winning hand for a greener future."

www.niauk.org/the-nuclear-roadmap

Six-point plan

The Forty by '50 report sets out six important short-term steps to turn aspiration into reality:

1. The nuclear industry must continue to drive down costs of new build projects and establish delivery excellence.
2. The government should articulate a clear long-term commitment to new nuclear power.
3. Progress must be made on an appropriate funding model for nuclear new build to stimulate investment in new capacity and reduce the cost of capital.
4. A national policy statement and facilitative programme, including siting and licensing proposals, should be developed for small reactors.
5. The 2030 targets of the Nuclear Sector Deal (which marked its second anniversary in late June) should be maintained, including cost reduction targets for 30 per cent for new build and 20 per cent for decommissioning, a 40 per cent female workforce, and £2 billion of domestic and international contracts for the UK supply chain.
6. Industry and government should agree a framework and commitments, focused on cross-sector collaboration outside traditional electricity production including the production of medical isotopes, hydrogen, and synthetic fuels for transport, along with heat applications including district heating, agriculture and storage technologies.

HVM Catapult leading the **green manufacturing revolution**

The High Value Manufacturing Catapult has published its annual review, capturing the impact of its work to lead a green manufacturing revolution and support the national response to the Covid pandemic.

The report highlights the HVM Catapult's capacity to respond to a crisis, as demonstrated by its leading role in the VentilatorChallengeUK consortium. CEO Dick Elsy co-ordinated the industrial consortium which successfully delivered around 13,400 ventilators, more than doubling the stock available to the NHS.

The report also illustrates how the HVM Catapult is responding to other challenges facing the UK. Last year, the UK committed to achieving net zero greenhouse gas emissions by 2050. The report shows how the HVM Catapult is already supporting this ambition, enabling innovation in transport, energy generation and manufacturing processes to drive down emissions and deliver economic impact.

"As the most significant advanced manufacturing research body in Europe, we are determined to use our position to help industry to get back on its feet after the Covid-19 crisis and, importantly, keep the torch lit for innovation," said Elsy. "This will be crucial to our competitiveness as all nations fight to return to a new normal.

"We will also use this opportunity to show leadership in driving progress towards achieving net zero by 2050. I know that the manufacturing community can deliver for the planet in a similar way it delivered for the country in its time of need. The High Value Manufacturing Catapult will step forward to play a full part in the UK's economic resurgence."

Meeting the challenge: Dick Elsy (right) with Penlon CEO Guru Krishnamoorthy.

The annual report includes summaries of dozens of projects from across the Catapult's network of seven specialist centres. Success stories from the Nuclear AMRC include:

- Developing new low-carbon reactors as part of the UK SMR consortium.
- Working with UKAEA on materials and modular construction for fusion reactors.
- Demonstrating single-platform manufacturing techniques for large nuclear components.
- Supporting regional manufacturers from Nuclear AMRC Midlands in Derby.
- Anchoring the innovation cluster at the Advanced Manufacturing Park in Rotherham.
- Helping companies enter new markets with Fit For Nuclear and Fit 4 Offshore Renewables.

Download the full review: hvm.catapult.org.uk/annual-review-2020

Dr Rahul Mandal, Nuclear AMRC researcher and star baker, cooked up a mouthwatering thank-you for the VentilatorChallengeUK team.

The cake replicating the Penlon ES02 ventilator was delivered to Penlon's Oxfordshire factory in early July as the last ventilator was dispatched to the NHS.

Large enough for more than 100 helpings, the cake was based on one of Rahul's winning recipes from *Great British Bake-Off* in 2018, and the largest he has yet made. It involved 12 chocolate tray bakes and two orange-flavoured cakes, held together with 4kg of chocolate fudge and 5kg of white chocolate ganache, and intricately decorated with over 6kg of fondant.

Working life at the Nuclear AMRC

During lockdown, members of the Nuclear AMRC team were invited to share their expertise and experiences on the centre's website. Here's insight from one of our most experienced colleagues, and a young engineer at the start of her career.

For more insight and comment from the team: **namrc.co.uk/news/comment**

Over the past four decades, James Turner – known to all as Jimmy – has worked his way from machining apprentice with the National Coal Board to shopfloor supervisor at the Nuclear AMRC in Rotherham.

I started my apprenticeship in the late '70s, when this area was predominantly coal and steel. My father insisted if I was going into coalmining, I did a recognised proper apprenticeship.

I did a four-year machining apprenticeship, and worked as a machinist all the way through until they started closing the mines. My engineer then got me a job at an oil and gas company, and that was the first time I'd ever clocked eyes on a CNC machine. I had to go to night school, and I did three years on CNCs.

I then did five years in Germany, working with exotic materials, and after I came back, I got a job in aerospace at Doncasters Bramah. That set me on the route to working with complex parts, which I found really interesting.

I got into this role because I knew that there were jobs coming through the university, and I knew that they did aerospace down in the AMRC. I really enjoy my job as a shopfloor supervisor, but I do miss being on machines because it's something that I've done all of my life.

The changes to machining practices over the years have been absolutely phenomenal, and what our machinists can do with the machines today is just sheer brilliance.

The advice I'd give to young engineers is to go as far as you can. The education system now is a lot better than when I started, and it's a great time to come in to be a machinist.

If you've got the opportunity, grab it with both hands. Learn as much as you can, because that period between being 17 and retiring might seem a long way, but I could tell you it's not.

Some of the guys on the shopfloor will tell you, you never ever stop learning. There's always something else to learn.

Beatriz Acevedo Gonzalez, a mechanical engineering student at Loughborough University, completed a year's placement at the Nuclear AMRC as an assistant research engineer.

I wanted to work at Nuclear AMRC because it is at the forefront of manufacturing technologies, and this excited me. It is a great place to work for problem-solving and investigation-based work, and I knew I would be working on essential skills that would benefit me in my later career.

During my time at the centre, I have learnt a lot of practical engineering knowledge. I have learnt about organisation in order to complete projects as planned, and to work effectively within a team.

I put myself forward for presenting virtual reality demonstrations to external visitors, which meant that I have continuously improved my skills with the equipment while also helping my presentation and confidence.

As the technical secretary to the research board, I also had the opportunity to learn a lot about the world-leading ideas discussed within the nuclear industry, and all the different organisations it takes to drive the sector. This knowledge and information was extremely valuable in helping me understand the industry in more detail.

One of my highlights at the centre was submitting an idea to the Spark! Contest, which is a British–French competition to produce innovative thinking. My team and I made it to the second round, which was supposed to be in Paris – but due to the pandemic, this was moved to a virtual platform.

The challenges I faced were when I didn't have the background knowledge I needed when starting particular projects and topics. This is why I decided to undertake a placement year, as it helped me expand my skills and knowledge.

I will take a great deal of skills back to my final year of university. In particular, I have noticed that I am a lot more organised with my time and have become a self-motivated individual.

My experience at Nuclear AMRC was extremely rewarding, and I enjoyed the working atmosphere and the people that I have met at the centre.

Things to come: Professor Keith Ridgway, one of the founding directors of the Nuclear AMRC, presents the vision for the new centre.

10 years ago: **a royal visit** remembered

On 18 November 2010, royal visitors came to the Advanced Manufacturing Park in Rotherham to launch construction of the new Nuclear AMRC.

Her Majesty The Queen, accompanied by HRH The Duke of Edinburgh, donned a set of virtual reality glasses to remotely activate a digger from within the AMRC Mantra vehicle, a customised lorry designed to give young people a taste of modern manufacturing technologies.

As a signal went out to the real digger on the site, the Royals saw a three-dimensional animation of the new building rising from the virtual ground.

Images of Her Majesty in VR glasses proved a hit with the world's media. As well as being featured in national newspapers, TV and industry press – including the cover of the *Sunday Times Magazine* and *Private Eye*, and the BBC's *Have I Got News For You* – the Nuclear AMRC gained unexpected publicity in the US, Canada, South Africa and beyond.

During their visit, the Royals met with apprentices and representatives from the Nuclear AMRC's key partner companies, and viewed plans for the new building and other developments.

Construction of the 8,000m^2 building was completed to schedule by autumn 2011, with the initial Nuclear AMRC team working from temporary offices and workshops elsewhere on the park.

Royal approval: photos of the Queen wearing VR glasses were a global media success.

Funding for the development included £15 million from the Department of Business, Industry and Skills as part of 2009's Low-Carbon Industrial Strategy, plus £10 million from the regional development agency Yorkshire Forward.

Events in the time of Covid

Industry events have long been seen as an essential way of making new contacts and sharing knowledge, but the Covid lockdown put a sudden halt to face-to-face meetings. Nuclear AMRC events manager Jo Byron explains how the centre adapted to online events, and looks forward to a hybrid future with the best of the virtual and real worlds.

Since joining the Nuclear AMRC in early 2017, I have played a key role in launching our new facilities and delivering our first major conference, as well as managing our regular calendar of visits, seminars and partner events.

That now seems like a different world. With the start of the Covid pandemic, events came to an almost complete standstill. We decided to cancel and postpone any events, visits and tours with immediate effect.

Over the past few months, I have seen the events industry emphasise the need to diversify into the virtual sphere. With so many webinars and virtual events filling the diary to replace in-person events, my initial challenge was to carefully consider the objectives and practicalities of launching our own webinars.

Our key focus is always on engaging our customers in the nuclear supply chain, providing support and sharing information on new opportunities. In early June, we reached out to our members and the F4N community with our first webinar, sharing our lessons learnt on managing a safe return to work. This was a huge success, and we are now planning a variety of webinars over the coming months.

I was part of a small organising group for the first UK World Nuclear Exhibition (WNE) networking event, in place of the full-scale WNE which has been postponed to December. This was attended by more than 150 people, with very positive feedback despite some technical problems on the day. On reflection, our committee agreed that there will be a continuing need for virtual events, but it's yet to be proven whether they can ever really replace the buzz, creativity and sheer vibrancy of a live event.

Like many other organisations and businesses, we need to adapt to virtual and hybrid platforms. Many key industry events are being considered as hybrid in 2021, but for now we continue to support and attend virtual activity.

I do think virtual events have a lot going for them, and I do feel they will continue to play a big part in the events industry even when live events return. They do offer some positive impacts, by avoiding carbon-intensive travel, saving delegates' time and expense, and offering more accessibility.

Virtual events are cost-effective for organisers, and because attendees can view the event from anywhere, we can offer much more flexibility to attendees and gain far larger audiences.

But you can never replace the networking value of face-to-face interaction, which inevitably has more impact.

Diary namrc.co.uk/news/events

Some of the events that the Nuclear AMRC will be attending or supporting in the coming months. Please be aware than plans may change in response to the developing pandemic situation and local restrictions.

Nuclear 2020: Roadmap to Net Zero

3 December, London

The Nuclear Industry Association presents its 20th annual conference, covering nuclear new build, decommissioning, export opportunities, skills and more.

www.niauk.org/event-listing/nuclear-2020

World Nuclear Exhibition

8–10 December, Paris

The leading marketplace dedicated to the global civil nuclear community, bringing together around 730 organisations from around the world.

www.world-nuclear-exhibition.com

Work **with us**

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

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

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

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

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

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

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

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