NUCLEAR AMRC news
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- Net-zero emissions
- Manufacturing and materials
- Digital engineering
- Young innovators
- Fit For Nuclear

Nuclear Innovation UK Conference special

CATAPULT
High Value Manufacturing

NUCLEAR INNOVATION UK CONFERENCE

R&D FOR THE NEXT GENERATION

The Nuclear AMRC hosted its first major conference in July, sharing the latest industry innovations with companies from across the UK.

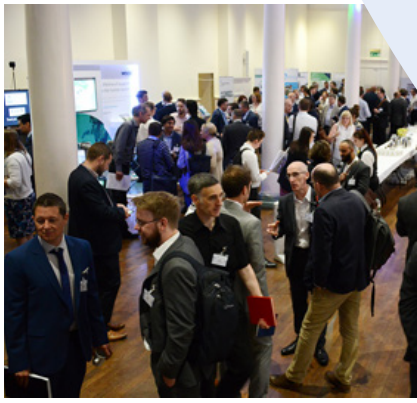
The Nuclear Innovation UK conference took place at Sheffield's historic Cutlers' Hall over 2–3 July 2019, with around 275 delegates including representatives from international organisations.

Organised by the Nuclear AMRC in collaboration with the National Nuclear Laboratory (NNL) and industry partners, the conference focused on research supported by the government-funded Nuclear Innovation Programme.

The Nuclear Innovation Programme is the UK's first public investment in future nuclear fission for a generation. Closely linked to the Nuclear Sector Deal launched in June 2018, the programme funds research into manufacturing and materials and supports the development of new designs of advanced reactor.

Alongside leading industry guest speakers, the conference included a series of technical presentations covering research projects from all areas of the Nuclear Innovation Programme – advanced manufacturing and materials, advanced fuels and recycling, and reactor design and engineering – plus a presentation competition for young nuclear professionals to showcase the freshest thinking on how the industry can drive innovation.

This special edition of *Nuclear AMRC News* brings you all the vital information and key messages from the two-day celebration of R&D for the next generation.



An industry in need of disruption

The UK nuclear industry needs disruption and innovation if it's to make its full contribution to reducing emissions, according to industry veteran Tim Stone in his keynote speech to the Nuclear Innovation UK conference.

Disruptive influence: Dr Tim Stone CBE.

A self-confessed disruptor with decades of experience in the energy and infrastructure industries, Dr Stone chairs both the Nuclear Industry Association and specialist underwriter Nuclear Risk Insurers.

Speaking a few weeks after the UK government committed to reduce net greenhouse gas emissions to zero by 2050, Stone emphasised the monumental size of the challenge. With electricity demand likely to double as transport and heating are decarbonised, the UK will potentially need to quadruple its low-carbon generation.

"This is the hardest thing we'll ever do in this country, bar none," he said. "Getting to zero by 2050 has some challenges in there that make your eyes water when you get down to the minutiae.

"Nuclear has a fundamental part to play – you can't do it without nuclear," he continued. "To get there, the industry has to do a lot better. We've got to shift. It's not just about little bits of innovation in hot isostatic pressing or whatever, we've got to do things differently."

The nuclear industry will need real drive and creativity to make a difference, Stone argued, contrasting nuclear's tendency to build everything as a bespoke project with the microelectronics industry's drive to standardisation.

Stone highlighted Russia's use of modular manufacturing techniques from the shipbuilding industry to produce small nuclear power plants for icebreakers, as well as opportunities to reduce the environmental impact of reactor construction. "Concrete for nuclear power plant is horribly carbon-intensive," he noted. "How about carbon-negative concrete? Why is nobody running round the industry saying let's look at this? That's been out there for years."

Turning to the financial challenges facing new build, Stone noted that infrastructure investors and pension funds are interested in the decades-long payback period and scale of nuclear projects, but are still put off by the cost, schedule and political risks.

The government has a role to play in reducing risk and supporting delivery of nuclear new build, he emphasised: "There are limits to markets – government can't sit back and say the market will sort these things. For big national infrastructure, if there's a problem then government gets the problem back. It's about the future of our children and grandchildren."

Government perspective

Speaking on behalf of the Department of Business, Energy & Industrial Strategy (BEIS), science and innovation director Damitha Adikaari also highlighted the challenges of increasing low-carbon generation to meet the zero-emission target.

"Power sector emissions need to continue to go down," he said. "If we talk about scale, nuclear is probably the only option we have."

Cost reduction remains the biggest challenge for nuclear, with the sector deal targeting a 30 per cent reduction by 2030.

The government launched the Nuclear Innovation Programme in 2016 as a first step to developing the technologies and capabilities that will help reduce costs, Adikaari said, but there's still a big task to achieve all its targets.

"We don't have a lot of time left," he noted. "To achieve net-zero, cost reduction is key. Other sectors are advancing rapidly, and nuclear needs to meet the challenge. That happens when efficient partnerships and collaboration happens."

Dr Fiona Rayment of the Nuclear Innovation and Research Office provided an update on the progress made by the programme, with more than £50 million of research investment already committed from a total pot of £180 million. More than 30 UK organisations have been involved in delivery, working with another 54 organisations from 16 countries. "There's absolutely an international dimension to this," she noted.

The Nuclear Innovation Programme aims to fill some of the key gaps in the current UK research landscape, and to apply learning from other sectors into nuclear.

"What we're very good at is doing a lot of the early stages of development, and then taking something that's pretty mature and actually taking it to market," Rayment concluded. "The bit in the middle is difficult because it needs a significant investment. There's a need to have a demonstration phase that takes some of these technologies forward."

Joined-up research for manufacturing and materials

An integrated weld monitoring tool developed in the Simple project is now ready to be installed in a factory for further development.

The Simple (Single Manufacturing Platform Environment) project aims to integrate a range of machining, fabrication and inspection operations onto a single manufacturing platform and reduce manufacturing costs by half for large components such as small modular reactor (SMR) pressure vessels.

Matt Smart of the Nuclear AMRC presented the latest results as part of a series of technical presentations covering advanced manufacturing and materials research funded by the Nuclear Innovation Programme.

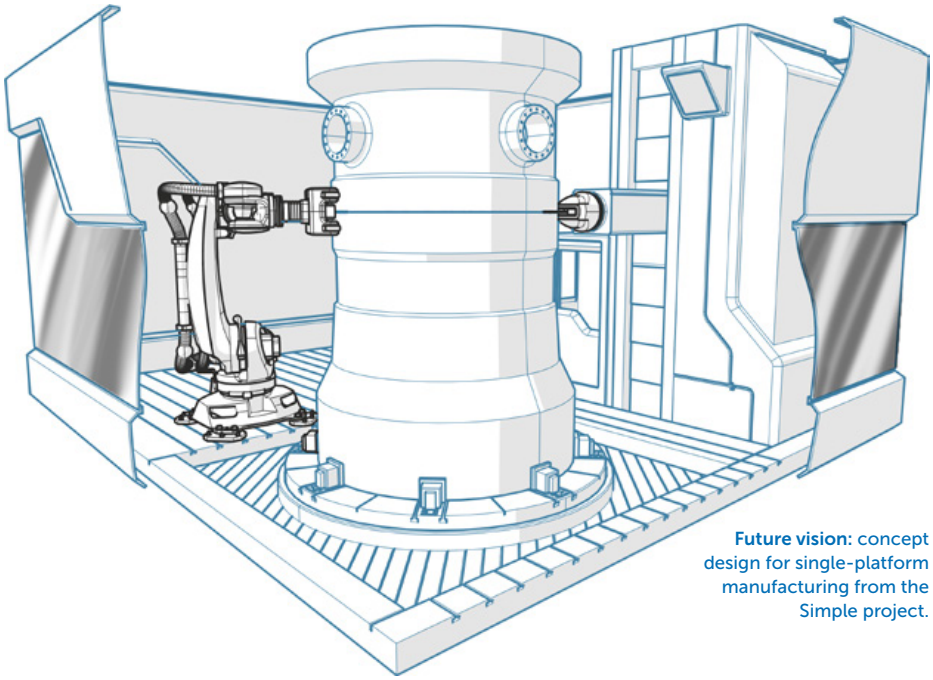
"You're removing as much non-value-added time as possible by doing as much in one place as possible," Smart told delegates. The Simple approach also enables digital co-location by maximising the transfer of quality data between processes, he added.

The first phase of the project, which ends in August, focused on developing an integrated weld monitoring tool which can remove the need for repeated testing of thick-section welds.

The Nuclear AMRC worked with partners to investigate a range of weld inspection, analysis and modelling technologies, integrated with a mechanised gas tungsten arc welding head.

Techniques developed by the Nuclear AMRC team include laser sensors for measuring weld geometry, electronic speckle pattern interferometry techniques to characterise the weld surface, and tools for acoustic analysis of the welding process.

The University of Strathclyde AFRC and Peak NDT collaborated on a high-temperature ultrasonic inspection system – a challenge for in-process weld monitoring, as the speed of sound changes with temperature. The demonstration system works well up to around 150°C, Smart noted.



Future vision: concept design for single-platform manufacturing from the Simple project.

Welding specialists TWI developed a visual inspection system and neural network for immediate identification of weld flaws and defects. Physicists from the University of Sheffield developed a process monitoring system to record and analyse the welding parameters and optimise the process, while the University of Sheffield AMRC developed a system to integrate the data from all sensors in real time.

The integrated head has been successfully trialled on SA508 pressure vessel steel using the Nuclear AMRC's Polysoude welding cell. For the next phase of development, the team would like to install the prototype into a working factory environment to gather real-world data and refine its defect-identification capabilities. "In principle, there's nothing stopping us taking our demonstration system and putting it into a workshop in a couple of months, initially for data gathering and training," Smart noted.

Conference delegates were able to see the Simple prototype weld head in action during tours of the Nuclear AMRC research factory at the Advanced Manufacturing Park.

Informed assembly

The factory visits also showcased the technologies being developed through the Inform project (Intelligent Fixtures for Optimised and Radical Manufacture), which aims to radically improve efficiency through

Huge benefits: the local-vacuum electron beam welding system developed for the Inform project.

the whole manufacturing process for large-scale nuclear components.

Inform technologies include near-net forgings, optimised machining, local-vacuum electron beam welding, advanced fixturing and digital technologies, with the aim of ultimately cutting cost and time for manufacturing large complex nuclear fabrications by at least 50 per cent.

Speaking at the conference, project lead Ben Cook presented the Nuclear AMRC's work to improve the efficiency of machining large forgings. "Because the surface of forged material is very rough, you don't have a lot of confidence in where the high and low spots are, so you're very conservative in your machining," he explained.

The team have developed new methods to take data from an optical scan of the raw forging and convert into a CAM format which can be used for rough machining. The method avoids having to create an intermediate CAD model, which can take a week, Cook noted.

In early trials, the technique showed a 40 per cent time saving for partial roughing of a test forging. "That's because it's only cutting where it needs to cut," Cook said. "We're quite confident that'll scale up to the whole part."

The Nuclear AMRC machining team are also investigating software to optimise the alignment of a forged workpiece, as well as advanced coolants such as supercritical carbon dioxide to further improve efficiency in rough machining.

Project partner Sheffield Forgemasters meanwhile led research into optimising the forging process for pressure vessel sections, including hollow ingot forging techniques which can remove several stages from the conventional method and reduce material waste. The Forgemasters team are also investigating real-time metrology technologies, such as laser tracking to measure hot forgings instead of relying on manual calipers.

Fixturing specialist MetLase developed a proof-of-concept demonstrator for an intelligent system which can handle an SMR pressure vessel assembly through the entire manufacturing process.

And TWI is working with Cambridge Vacuum Engineering (CVE) and other partners to develop local-vacuum electron beam welding technology, to join very thick vessel sections in a single pass without needing a vacuum chamber large enough to contain the entire assembly.

Material benefits

Local-vacuum electron beam welding is one of four technologies being investigated by the Mattear project (Materials & Manufacturing Technology Evaluation for Advanced Reactors) to better understand the material effects of new manufacturing processes.

"You have the huge benefit of a single pass where you might need several hundred passes to manufacture with arc welding," Dr Andrew Wisbey, project lead for Wood,

Nnuman community

Members of the Nnuman community also discovered the welding research being carried out through the Nuclear Innovation Programme at a meeting in June. Hosted by TWI in Cambridge, the community's third meeting also discussed university-based projects on weld modelling, defect detection and additive manufacturing.

The Nnuman community is led by the Nuclear AMRC and The University of Manchester, and developed from the technical advisory board for the EPSRC-funded New Nuclear Manufacturing programme which ended in 2017. Membership is open to anyone interested in collaborative R&D in nuclear manufacturing.

namrc.co.uk/services/nnuman

told delegates. Current research focuses on comparing electron beam welding in a low vacuum with conventional high-vacuum welding, with welding trials at the Nuclear AMRC and TWI on SA508 and 316L steels.

Other technologies being investigated by the Mattear consortium include transitional joints between different grades of steel without the need for complex multi-alloy welds, hot isostatic pressing of metal powder for near-net shape forming, and additive manufacturing with 316L stainless steel.

Dr Andrew Moffat of Frazer-Nash Consultancy presented work from a related project to remove some of the blockers to power beam welding in the nuclear sector. The project focuses on the material properties of welded sections, including new modelling techniques to predict residual stress, probabilistic methods for structural integrity assessments, and fracture modelling including the effects of thermal ageing.

Shipbuilder Cammell Laird is also investigating local-vacuum electron beam welding for SMR pressure vessels through the EBManPower project. Project lead Jamie Willgress explained how the company is working with TWI, CVE and SMR developer U-Battery to demonstrate CVE's Ebflow technology on a thick-walled stainless steel pressure vessel. The Ebflow equipment has passed factory acceptance testing, and will be commissioned at Cammell Laird by the end of the year.

EBManPower builds on the Fit For Modules project led by Cammell Laird to lay the groundwork for the wider adoption of off-site modular construction across the nuclear sector. The project's first phase set out how modularisation can reduce project risks and costs while improving quality and safety, and produced a detailed roadmap based on extensive industry consultation on how modular construction techniques can be developed.

Cammell Laird's Jonathan Brown presented an update on how the roadmap is progressing, and emphasised the need for genuine collaboration between reactor developers, manufacturers and regulators. A greater degree of modularisation can avoid many of the cost and schedule risks of on-site build, he noted.

"By moving some activity off-site, you can de-risk activity," Brown said. "It's not either-or – it's a complementary situation of on-site and off-site construction."

Research factory: conference delegates explore the Inform technologies in the Nuclear AMRC workshop.

Code acceptance

Any new manufacturing technologies developed for the nuclear sector will have to be accepted into the design codes for new reactors. Dr Peter James of Wood is leading a project to understand the areas of the international nuclear design codes which would need to be developed or modified, and the additional requirements of the UK regulator's Generic Design Assessment process.

"You need to demonstrate that, throughout the lifetime of a plant, that component isn't going to fail," James said. "And you need to show that any data used are appropriate."

Showing that an innovative process is compliant with current nuclear codes isn't enough for the UK regulator, he noted – you need to show you've gone beyond code compliance to show that it's safe and the risk of radiation release is as low as reasonably possible.

The first phase of the study looked at how well the UK is placed to influence the international ASME and AFCEN design codes, and found that UK organisations are represented on only eight of the 60-plus committees that oversee the codes. Other countries have established national working groups to ensure that they have an influence, and James recommended that the UK do likewise.

The researchers are now engaging with industry to better understand what areas of the various codes will need to be developed to bring new designs of reactor to market, focusing on pressure vessel and piping manufacture, and best practice guidance for modularisation and design optimisation.

Advanced fuel research

Researchers from NNL presented a host of projects funded by the Nuclear Innovation Programme into advanced nuclear fuels and reactor physics.

With enhanced accident tolerance a high priority for the industry, Dave Goddard introduced work to develop new fuel and cladding concepts which could be deployed in light water reactors. Manufacturing these fuels domestically would support the strategically important UK fuel manufacturing capability and its supply chain, he noted.

Understanding the behaviour of advanced nuclear fuels while under irradiation is also vital, and Glen Rossiter discussed how NNL is developing computer-based reactor physics modelling to support advanced fuel development and the future UK reactor fleet.

New approaches to recycling spent fuel can radically reduce costs and environmental risks, noted Robin Taylor, and help maintain key skills in the UK supply chain. NNL has worked with universities and industry partners to evaluate a number of processes, and is now starting a second phase to further develop the most promising technologies.

Spent fuels and related waste also have the potential to be converted into products of value to other sectors. Tim Tinsley discussed potential applications including medical radioisotopes or power cells for space exploration.

Regulating for innovation

New ways of working could reduce the project risk and cost of new reactor technologies, according to the UK's nuclear regulator.

Speaking at the conference dinner, Adrienne Kelbie of the Office for Nuclear Regulation (ONR) discussed the regulator's role in industry innovation.

"I am in no way, and nor is ONR, a nuclear cheerleader, but the UK government has set out very clearly its clean growth strategy and it has identified nuclear as a potential energy source," she told delegates. "ONR does play a critical role in enabling your delivery of that – or not. If it's not safe, it simply won't happen. If it is safe, we can and do help industry work in ways which are new to you, new to us, and are sustainable and offer the best possible value to the public purse."

ONR is constantly developing its capabilities to deal with innovative technologies, Kelbie explained, improving its processes and increasing team diversity to help think more creatively and laterally in how it regulates.

Kelbie challenged the industry audience to engage with more diverse groups – including non-government organisations which may oppose nuclear – so that they have direct access to information on which to make their views. Only a third of people in the UK support nuclear, she noted, including 45 per cent of men but only 26 per cent of women. She urged industry to tackle this.

ONR has developed its understanding of small and advanced modular reactor technologies, and studied how innovative safety-critical technologies are regulated in other countries and industries, to ensure that the team are ready to assess new reactor designs.

"I do think that SMRs and AMRs really are bringing innovation to decades-old technology," Kelbie said, noting the benefits of the regulator's early advice to BEIS and other stakeholders.

The regulatory process can influence the costs of new nuclear power, she emphasised, referring to research by the Energy Technologies Institute that showed how the cost for nuclear power is driven by the cost of capital which can reflect political uncertainty. ONR's new strategy for 2020–25 will address how it can help industry avoid unnecessary costs, she noted.

"ONR positively welcomes all ideas to help the industry and the supply chain operate to the standards we demand, with reduced risk and cost," Kelbie concluded.

www.onr.org.uk

International opportunities

The UK nuclear industry is strengthening its international links ahead of Brexit, a government advisor told the conference.

The UK has signed a nuclear cooperation agreement with the US and is progressing partnerships with other countries including China, Japan, Poland and Canada, said Steve Napier from the Nuclear Innovation and Research Office. The UK has also signed up to the Gen IV International Forum, a cooperative group to drive research and development for advanced reactors, and is reviewing membership of organisations such as the International Atomic Energy Agency (IAEA).

The UK has leveraged a lot of work out of European programmes such as Euratom, Napier noted, and is seeking an agreement which will allow that cooperation to continue. "The worst case position is we may have to participate in the same way as the US and other countries as a third-party country," he said.

Adam Bond of the Nuclear AMRC presented an update on an industry collaboration to grow the UK's nuclear exports. The Winning UK Business working group, overseen by the Nuclear Industry Council as part of the Nuclear Sector Deal, comprises around 20 organisations and aims to help deliver at least £2 billion of UK and international orders by 2030.

The group is now working to develop a framework to identify what export opportunities are potentially available in different countries, and to pinpoint where the UK needs to innovate to increase its international competitiveness.

Look to other sectors for innovation

The nuclear industry needs to embrace innovations and new ways of working from other sectors, according to leading researchers and manufacturing experts.

Introducing the opening session for the second day of the conference, National Nuclear Laboratory CEO Paul Howarth emphasised the need for the industry to embrace the innovation it requires to meet the challenges facing the energy sector.

In his other role as chair of the Association for Innovation, Research and Technology Organisations, Howarth sees a rapid pace of innovation across a range of industry sectors.

"If you look at the technologies out there being developed, whether quantum computing or robotics or digital technologies, they're moving rapidly and they're seeing immense changes happening in their industries," he said. "In the energy sector, if we look at some of the other technologies, we are seeing rapid innovation happen as well. We are seeing costs of new generation dropping rapidly.

"We need to look at nuclear from the point of view that this could be a bit of a near-death experience for us. We have to get nuclear right, and we have to embrace innovation."

Nuclear could still be considered as a nascent industry, Howarth suggested, with little fundamental innovation in reactor design since the early days of nuclear power. By contrast, technologies such as mobile phones have changed almost beyond recognition in a few decades.

Allan Cook CBE, chair of the High Value Manufacturing Catapult and former chair of infrastructure group Atkins, also drew on his industry-crossing experience. In his other current role as chair of HS2 Ltd, he is heading a transformational project for the UK which has to demonstrate value for money.

"The build we're doing within HS2 has to be impeccably engineered, and that means investment in the way we innovate and the way we design and build those systems," Cook said. "Innovation is at the heart of everything that we have to do, and innovation has to be at the heart of everything that we do within the nuclear industry."

Industry-crossing expertise: compère Nina Warhurst with Duncan Steel, Andrew Sherry, Allan Cook and Paul Howarth.

Achieving the UK target of net zero emissions by 2050 will require investment of £50–70 billion a year, Cook noted. He concluded by repeating environmental campaigner Greta Thunberg's call for "cathedral thinking" to tackle the climate crisis: we must lay the foundations now, even if we may not know exactly how to build the ceiling.

Professor Andrew Sherry, chief scientist at NNL, discussed how other sectors have been transformed by disruptive innovation, and how NNL is now working with a range of industries to identify technologies and practices that can be transferred into nuclear.

"We need to be disrupted. What comes very clearly from the roundtables and workshops is that it's not just about technology – it's also about culture and practice," Sherry said. "The culture we have within our sector has largely remained unchanged for 40 years. This represents a major challenge, and this is the disruption we need to think about."

Nuclear decommissioning also requires new ways of thinking, noted Sellafield CTO Duncan Steel, who joined the nuclear group after 27 years in the aerospace industry. "I've found brilliant people and great ideas, but they are tethered in some way to the past 20 or 30 years of working," he said.

"What we do is really changing at Sellafield, and how we're going about it is by heavily investing in research and development, and promoting innovation with unique opportunities. But we can't do it alone – we are supporting our supply chain, we are collaborating and building partnerships better."

Sellafield is now working with partners to investigate remotely-operated drone technologies to remove humans from hazardous areas, "smart city" technologies to manage waste stores, and standardisation techniques from the oil & gas sector.

The nuclear sector needs to adapt technology and ideas from other sectors, and innovate in everything, Steel emphasised. "If you can steal it from somewhere else and use it, do that," he said. "In terms of innovation, we have to be more ambitious than we think we can be."

Virtual reactor design enters next stage

A project to develop a nuclear virtual engineering capability to improve the design of new nuclear plants is now entering its second phase with over £3 million funding from the Nuclear Innovation Programme.

The first phase of the digital reactor design project led by Wood successfully demonstrated a software framework which can bring every stage of design together on a single platform with a common data set. That will help reduce costs and timescales in the development and licensing of new reactors and throughout their life, project lead Dr Ahmed Aslam told delegates.

"Having all the data under one roof means it can be shared more easily," Aslam said. "If we have one single environment and a single design, and everyone is able to access the same design information, you see the same environment and can test conformance against the performance criteria."

The second phase of the project, announced in May, will focus on implementing digital tools within the software framework. It will use real project applications to demonstrate improved efficiency, enable supply chain collaboration, and deliver cultural change across the industry.

In the first phase, the framework was tested against case studies from current reactor programmes. "They have demonstrated that what we have developed is working," noted Dr Albrecht Kyrieleis of Wood, technical lead for the ongoing research. "We want to further develop this framework. Our aim is to bring this beyond proof of concept, to demonstrate that there are real benefits from using this."

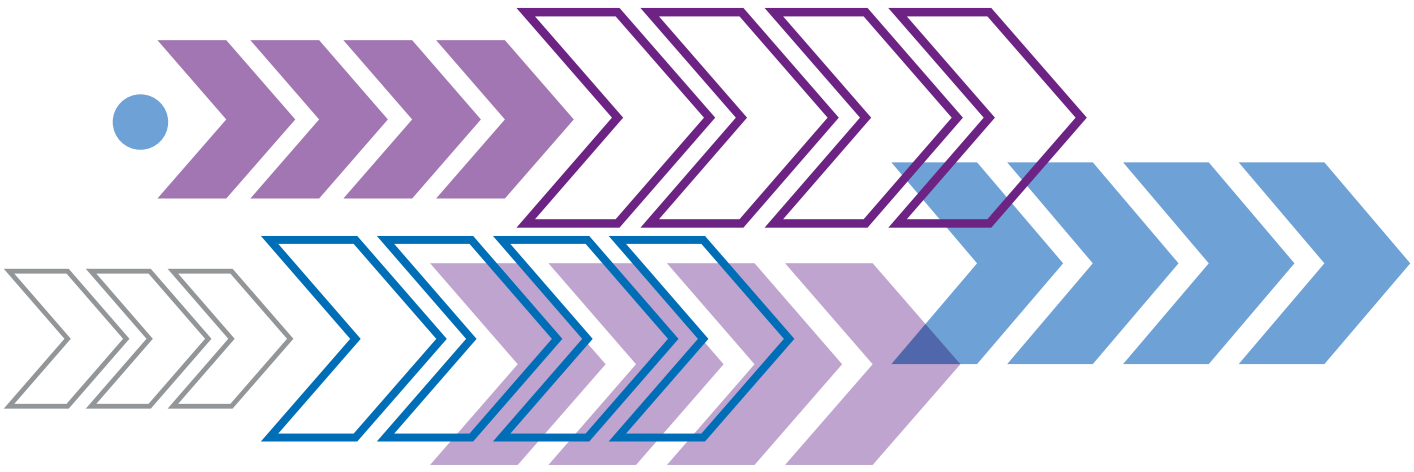
The Nuclear AMRC will work with Wood to integrate manufacturing data into digital models to better understand performance over the life of the reactor. Other partners include EDF Energy, Rolls-Royce, NNL and the University of Liverpool's Virtual Engineering Centre.

Safety remains at a fundamental concern for any nuclear programme, and another project funded by the Nuclear Innovation Programme is developing new techniques to provide insight into reactor safety and security performance.

David McNaught of Frazer-Nash Consultancy explained how the project will enable risk-informed decisions that reduce conservatism and drive down costs, by tackling areas including reactor design, security modelling and assessment, and the safety case for introducing programmable devices into control systems. Learning from other safety-critical industries will be key to establishing robust techniques for assessing the safety of control and instrumentation systems, McNaught emphasised.

Frazer-Nash is also leading work to specify the new national nuclear thermal hydraulics facility as part of the Nuclear Sector Deal. After initial work on numerical model specifications and initial development, the second phase will deliver technical volumes and case studies, combined with industry-led research and integration with the other projects in the Nuclear Innovation Programme.

The final technical presentation focused on lessons from the past. Dr Nicholas Barron of NNL is leading a project to capture knowledge from the UK's fast reactor programme, which ran from the mid-1950s to the 1990s. The project involves scanning and digitising records, including some 500 tonnes of paperwork recently moved from Dounreay, to support future reactor programmes which use related technologies.



Young professionals showcase fresh thinking

To showcase the industry's emerging talent, members of the Nuclear Institute's Young Generation Network and other nuclear professionals aged 18–36 were challenged with answering one of the most pressing questions facing the industry: **how can the nuclear industry drive innovation in the supply chain?**

Following initial submissions by email, the 10 most innovative thinkers were selected to present their ideas to the conference in a two-minute elevator pitch.

Delegates used the conference app to rate each presentation, and the three highest-scoring individuals were rewarded with one-to-one mentoring sessions with their choice of the senior speakers, as well as the opportunity to share their ideas in industry publications.

Nuclear AMRC News is proud to present the winning ideas from Naomi Rutledge of NNL, Amr Saleh of BEIS, and James Leatherland of the Nuclear AMRC.

Thanks to all the presenters:

Hannah Fenwick, NNL
Henry Cathcart, Frazer-Nash Consultancy
James Cornish, Frazer-Nash Consultancy
Joseph Nielson, Antech
James Gath, NNL
Thomas Jackson, Atkins
Will Trewinnard, Atkins

Removing barriers to innovation

Many individuals have ideas for how we can innovate, whether that's to change a process, change the purpose of something, or create something new entirely. The supply chain is aware that the nuclear industry wants and needs innovation, but innovation carries a hefty time, money and reputation risk which the supply chain does not want to take on. Sometimes specific capabilities, equipment and facilities are required to innovate, increasing the risk even further.

To allow the supply chain to innovate, we must decrease these risks. By making innovation a part of bids, or by providing extra funds for innovation, we can share the risk with the supply chain, ensuring that they can innovate without risking their profit margin.

The financial risk can also be decreased by loaning capabilities, equipment or facilities free of charge or at an extremely reduced rate. This reduces the time, effort and money that the supply chain would have to spend, and would allow the supply chain to follow the market by innovating. Even then, there is still a reputation risk associated with innovation.

What do WD-40 and bubble wrap have in common? They both failed on their first attempts. Bubble wrap was originally supposed to be a textured wallpaper, which obviously did not work out well. WD-40 stands for water displacement – this was the 40th attempt. Both prove that failure at the first attempt doesn't mean failure overall.

Have you thought of what the next steps might be for an innovation? Could this result be applied in another way? Was this innovation ruled out as an option? By focusing more on what was learnt rather than the result, the reputation risk associated with innovation can be reduced.

Simply talking about innovation isn't enough. We all have innovative ideas, but how often do we follow these through, even when the entire industry can agree that the innovation would be well accepted? How many times have we collectively thought that standardisation would be an amazing way to reduce costs and is something we should be doing? And how many times have we innovated in the way we work to apply this?

The sooner we start, the more we can innovate and the more innovations we will have in 10 years' time. The sooner we innovate, the more chances we have for success.

– **Naomi Rutledge** works in the thermal and structural modelling team at NNL. She will be mentored by NIRO director Fiona Rayment.

Weaving our digital thread

We all know that great innovation occurs when you move from one curve to the other, from the phone to the smartphone, or the 2D printer to the 3D printer. The real question for me is: what do our engineers look like on the other side of this curve? He or she will probably be connected to a supercomputer and a big AI system, where the human is essentially merged with a digital and virtual world.

Many pockets in the nuclear industry recognise the opportunities and challenges of digital. Some are taking bold actions, and some aren't. I believe that if the industry wants to see real value being delivered through digital technologies, then we need to take a more holistic approach to digitalisation.

Rather than implementing randomly-selected buzzword technologies like blockchain onto random processes, let's get the process right. Let's build a common language for data and knowledge, with an agreed way of understanding and capturing the digital flow of information through the entire nuclear life cycle.

This is called a digital thread. It isn't a software and it isn't a product, it's an approach. The digital thread should be able to tell us the history of any component or operation in the entire nuclear life cycle.

With a digital thread, the engineer of the future can see exactly how an idea went from someone's mind to being modelled, manufactured, put into a plant, taken out of a plant and out of operation, and finally stored as waste. The digital thread connects the entire nuclear life cycle, from conception through to decommissioning.

A digital thread can drive innovation because we wouldn't have to rely on tacit knowledge of why designs are the way they are. Those designs and the data behind them can be shared across the supply chain to help break down silos across the industry. And using shared data to collaborate across the value chain will allow for more services such as predictive and preventive maintenance.

In a world where we are building SMRs, AMRs and fusion reactors, the industry will have to demonstrate the robustness of first-of-a-kind technology without plant operation history. A digital thread will be able to clearly tell the story of the designs and assumptions used to underpin the engineering, giving confidence to regulators and investors.

I believe that digital offers an opportunity to change the way we design and license reactors, and also change the way we work together. But the first step should be weaving our nuclear digital thread.

– Amr Saleh is on secondment to BEIS from NNL as a strategic advisor. He will be mentored by NNL CEO Paul Howarth.

Unlocking TRLs in the nuclear sector

Technology readiness levels (TRLs) are a nine-step systematic way to track the progress of new technologies through to deployment, originally designed by Nasa. For once, we have a standardised system that, despite its cosmic routes, isn't rocket science. In the nuclear sector, however, it is a process that we seem to struggle to get to grips with.

Many describe TRLs 3-6 as the "valley of death". For years, taking ideas from proof of concept to system prototype was seen as the most difficult part of technology development. In the past decade, the UK (like many other industrialised economies) has filled that valley by investing heavily in research programmes through EPSRC and Innovate UK, Catapult centres, site licence company R&D budgets and national laboratories.

We are now rich in funding, resources and facilities in this valley. Many will argue that the UK needs to invest more in technology to truly become a world leader in new nuclear and meet the net zero carbon emissions commitment but, for the challenges we face today, investment has and is being made. Despite this, the impact of that investment has either been limited or the benefit has not been tracked very well.

Technology development in the nuclear sector is difficult. It is particularly difficult when transitioning from TRL6 to TRL7 – from technology demonstration (off-site, inactive) to system prototype (on-site, active). At this critical point, new and difficult questions get asked of the technologists and researchers which aren't generally the primary concerns in academia and R&D organisations. How are we going to buy this? Who benefits from the IP? Will this replace my job? Won't this make my job harder?

We need to tackle these commercial and cultural barriers to technology deployment, and integrate them with technology much earlier in the TRL process to deliver what the nuclear sector needs. Rather than a valley of death, our sector has a multi-layered nuclear licence fence in the way of realising the benefits of new technology. We have crossed the valley of death, now we need to address the gap between TRL6 and 7.

– James Leatherland is a project manager at the Nuclear AMRC. He will be mentored by ONR CEO Adrièn Kelbie.

Making the case for nuclear

The nuclear industry needs to revitalise itself to meet the challenge of net-zero emissions, argued Professor Ian Chapman, CEO of the UK Atomic Energy Authority.

Despite growing public concern about the need to cut emissions and new government legislation, the industry still needs to make the case that nuclear power – both fission and fusion – is the solution to the climate crisis, he said.

"We need nuclear. The ground could not be more fertile. We have a government that's pro-nuclear, we have a nuclear sector deal, we have this net-zero law, yet despite that fertile ground the crop is not growing," Chapman told delegates at the conference dinner. "If nothing else, that should be a massive wake-up call for this room."

UKAEA is forced to innovate by the massive challenges of fusion projects, he noted.

"Everything we do just sounds mad," he said. "It's science fiction, and yet we're absolutely doing it."

The international Iter collaboration involves a vacuum vessel made of 300 tonne sections assembled by a 30 metre tool, with restraint rods which could hold down a lunar rocket, and a solenoid with a magnetic impulse powerful enough to lift an aircraft carrier.

"All of these things are massive challenges, and that forces us to innovate," Chapman concluded. "We really, as a sector, must do much more of that."

gov.uk/ukaea

Look forward to the **next phase of nuclear innovation**

The Nuclear Innovation Programme is preparing to open the next round of proposals for advanced manufacturing projects.

Si Dilks, head of the nuclear innovation team at BEIS, gave a taste of the programme's future in his closing talk to the conference. The team are now preparing the next phase of calls for advanced manufacturing, materials and fuels projects, and carrying out scoping work for the proposed thermal hydraulics facility.

The new manufacturing calls are likely to be for shorter-term projects, capable of delivering impact within 12–18 months. Delivering the second half of the programme to schedule will be challenging, Dilks noted, but rapid progress is needed to build capacity in the UK supply chain and deliver a new generation of advanced modular reactors (AMRs).

"We want to change the way we build nuclear," he said. "We don't want to do it in the same way for the AMRs out there."

The first tranche of projects raised the international profile of the UK nuclear industry's innovative capabilities, Dilks noted, and the future programme will look to build grand collaborations with other major nuclear nations.

"Net-zero sets a massive challenge, but it also sets a massive series of opportunities," he concluded. "Now is the time to decide how you want to get involved with the Nuclear Innovation Programme and who you want to get involved with."

www.gov.uk/guidance/funding-for-nuclear-innovation

Executive **view**

Turning talk into reality

Our first Nuclear Innovation conference proved to be a great success, but our challenge now is to turn all the talk of disruption and innovation into reality.

As you'll have read over the previous pages, there was a lot of enlightening and provocative talk from everyone who came to Sheffield for the two days – talk about the innovations that are already happening in our industry, and what we need to do to tackle the massive challenges that face us all in providing secure, affordable, low-carbon power for generations to come.

We need to convert ideas into impact, and we need to invest to make that happen. We heard in the technical presentations and the site visits to our workshop that that is happening, thanks to support from the Nuclear Innovation Programme and other initiatives, but there's still a long way to go.

Sheffield is no stranger to innovation and disruption, and Cutlers' Hall provided an ideal venue for our conference. We were constantly reminded of how Sheffield's engineers and steelmakers have delivered many innovations over the centuries, from the crucible technique to stainless steel. In the 19th century, they established technical schools and colleges to give them the skills and technologies they needed to compete, laying the foundations of the University of Sheffield where the Nuclear AMRC continues that mission today.

Since Cutlers' Hall was built at the height of the first industrial revolution, the vast growth of industrial activity around the world has created its own challenges. We have increased the concentration of carbon dioxide in the atmosphere by almost half – and that concentration is still increasing, putting us on the brink of a global climate catastrophe.

The UK government has now committed to zero emissions of greenhouse gases by 2050, and other countries are doing likewise. To deliver that, we need nuclear power as part of the energy mix. We need new designs of advanced reactor – fusion as well as fission, powered by new kinds of fuel – made from innovative alloys using advanced manufacturing processes, and operated in new ways for enhanced safety and security performance.

To deliver this, we in nuclear need to be more prepared to learn and adopt new ways of thinking and working from other sectors, and to all work together to develop them for the particular demands of our industry.

The conference was one step towards making that happen. I'd like to give my thanks to everyone who made it happen – our own team at the Nuclear AMRC and at all our partner organisations, and to everyone who came to Sheffield for two days to discuss how we can really drive innovation in our industry.

To maintain momentum, I would like the Nuclear Innovation conference to become a regular event – and I'd like to take it beyond the UK to become a global innovation conference. I'm also very aware that we need to make it a more diverse event, bringing in other sectors and a broader demographic among the speakers and the audience.

It was great to see that the younger generation of nuclear professionals who took part in the presentation competition showed a much broader mix than the (let's say) more mature speakers on the expert panels, and it was a genuine pleasure to hear the fresh thinking they brought. These are the people who will be responsible for achieving our national commitment of zero net emissions by 2050, and the people who will be hit hardest if we fail to act now.

What we are doing is great, but to really change we need to do more and faster. Bigger, bolder strides will enable what we all want.

Andrew Storer, CEO, Nuclear AMRC

EPRI joins for SMR collaboration

The Electric Power Research Institute (EPRI) has joined the Nuclear AMRC as a tier one member.

With laboratories and offices across the US, EPRI works with organisations in 40 countries to investigate new technologies for the generation, delivery and use of electricity. An independent non-profit organisation, it focuses on research and development for the benefit of the public.

EPRI's advanced nuclear technology programme focuses on new reactors which could be deployed around the world, including light water small modular reactors (SMRs) and advanced reactor designs based on Generation IV technologies.

The Nuclear AMRC and EPRI are currently midway through a four-year collaboration to develop new manufacturing and fabrication methods for reactor pressure vessels, with the objective of reducing the total time needed to produce a SMR pressure vessel from around two and a half years to less than 12 months. The project is funded by the US Department of Energy, and involves industrial partners on both sides of the Atlantic including Sheffield Forgemasters.

The Nuclear AMRC recently completed two major technology development projects as part of the collaboration, covering diode laser cladding and electron beam welding techniques. The electron beam project successfully demonstrated that girth welds of large vessel sections can be completed in less than 60 minutes.

Membership will allow EPRI and the Nuclear AMRC to work more closely on joint research into advanced manufacturing processes and structural materials. The collaboration will focus on the development and demonstration of SMRs, developing techniques such as powder metallurgy, electron beam welding and additive manufacturing, and addressing challenges in areas such as codes and standards.

EPRI will also work with the Nuclear AMRC's modularisation facility in Birkenhead to explore modular solutions to reduce construction costs and improve new build schedules, and the new controls and instrumentation team at Nuclear AMRC Midlands to develop technologies to increase operational efficiency for reactors.

www.epri.com

Government proposes support for UK SMR

The government is proposing to invest up to £18 million in the UK SMR consortium.

The consortium proposes a joint investment between industry and government of more than £500 million to support the design a first-of-a-kind small modular reactor (SMR) power station.

In one of his final announcements as Business and Energy Secretary, Greg Clark confirmed in July that the consortium's proposal has been accepted into the Industrial Strategy Challenge Fund. An initial award could be made in early autumn, subject to final decisions to invest.

The UK SMR consortium comprises Rolls-Royce, Assystem, SNC Lavalin, Wood, Arup, Laing O'Rourke, BAM Nuttall, Siemens, the National Nuclear Laboratory and the Nuclear AMRC.

The initial investment will be used to mature the design, address the considerable manufacturing technology requirements and progress the regulatory licensing process. The consortium says that the funding will also give companies in the UK supply chain the confidence they need to plan investments in capability.

The consortium aims to have a first SMR operational in the early 2030s, around five to six years after completing the licensing process.

Quality first for TSP Engineering

TSP Engineering is the world's first company to be certified to a new quality standard designed specifically for nuclear suppliers.

Cumbria-based TSP Engineering, a tier one member of the Nuclear AMRC, secured the new ISO 19443 certification in June following an intensive audit.

"It gives us a fundamental string to our bow, to better show to customers that there's a major differential between using us and using other companies," says chief executive John Coughlan. "It allows us to demonstrate our ability to consistently provide products and services to customer requirements and all the applicable regulatory and statutory requirements."

The new standard was published by the international organisation for quality standards ISO in June 2018, and developed in close collaboration with the International Atomic Energy Agency (IAEA) and other nuclear experts. It applies the principles of the widely-used ISO 9001 standard to the nuclear sector, combining best practice in quality with the specific requirements of the nuclear supply chain.

Coughlan's team first learnt of the new standard through the Civil Nuclear Sharing in Growth (CNSIG) programme. Managed by the Nuclear AMRC from 2013–17, CNSIG gave key nuclear suppliers a tailored programme of business development and training. As part of its development, TSP Engineering was granted Fit For Nuclear status in 2015, and recently renewed its status to the latest F4N standards.

The company's journey through CNSIG and F4N definitely helped in meeting the standards of ISO 19443, Coughlan says: "Putting ourselves through the more advanced F4N standards has continued to give us focus and sharpened us to be able to go and get certification for 19443.

"F4N has changed us. It made us think more long-term about what we're doing in the nuclear business and our longer-term strategies. It really helped us drive our business forward."

TSP Engineering was certified to ISO 19443 by Lloyd's Register, whose extensive nuclear experience meant its auditors were able to quickly grasp the new standard. Satisfying the auditors did require additional investment for the company, however.

"We had to majorly change how we constructed our quality management system, and brought in some new software and hardware to connect everything and help us manage our way forward," Coughlan says. The new system is based on Agility software, which provides a streamlined cloud-based platform for all the required documentation.

The new certification will help TSP Engineering expand its work in the decommissioning sector, including potential international work. The company is also pursuing opportunities in new nuclear developments, including work on new designs of advanced modular reactor (AMR) and small modular reactor (SMR).

Space to deliver: TSP Engineering has some of the UK's most comprehensive workshops for precision engineering.

"The last programme we delivered for Sellafield was a four-year programme, and we delivered it early and below budget," Coughlan notes. "It's that kind of mindset and approach to what we're doing that we think differentiates us from other people."

TSP Engineering also offers unique physical capabilities. Its workshops in Workington on the Cumbrian coast are some of the most largest and most comprehensive in the UK, with almost 20,000m^2 of shopfloor, five-metre deep manufacturing pits, and 130 tonne lifting capacity. "We look on our business as heavy engineering with Swiss watch precision," Coughlan says.

With its origins in a war-time Ministry of Supply factory, the business has in past decades been part of British Steel, Corus, Tata Steel and, most recently, the revived British Steel group owned by Greybull Capital. As an operationally independent arm's-length subsidiary, TSP Engineering is not part of the group's current insolvency process but is likely to emerge with a new owner.

"We secured 19443 just after British Steel went into insolvency, and that helped reaffirm that we were a separate business that continues to grow," Coughlan says.

"For anybody who's interested in nuclear new build of any type, including SMRs and AMRs, this is essential," he concludes. "Anyone looking at supplying into the nuclear sector should be looking at this standard."

www.tsp-engineering.co.uk

F4N
Fit For Nuclear

Syspal prepares for decommissioning opportunities

Based a stone's throw from Ironbridge Gorge in Shropshire, fabrication specialist Syspal sits at the heart of the original industrial revolution. Today, its state-of-the-art factory is ready to seize the opportunities of the fourth industrial revolution of digital manufacturing, and move into the demanding nuclear market.

Unique production: Chris Truman and Ray Hoffman with one of the firm's laser cutters.

Founded in 1975 to serve the food industry, Syspal has become one of Europe's most advanced fabrication shops for stainless steel and aluminium, supplying industries where cleanliness and quality are paramount. Its 10,000m² factory is a showcase for advanced manufacturing equipment, with Industry 4.0 technologies integrating its automated presses and laser cutters with design and production management.

"For a fabrication factory, we can say with confidence that it's as good as any in Europe," says managing director Chris Truman. "We have spent considerable time over years researching the most efficient production machinery and systems, resulting in a quite unique combination."

The food processing sector still accounts for the bulk of production, from hygiene rooms through to specialist machines for product handling and transfer.

Syspal also produces a successful line of veterinary products – including hydrotherapy training tanks for dogs – while its sub-contracting arm, Manifab, produces short-run components and complex bespoke assemblies for industries such as aerospace, defence and rail.

After being contracted to design and produce a degassing room for a leading engineering services company, Truman began to look at further opportunities in nuclear. "We were intrigued about that industry, realising this was an opportunity to further improve our quality systems and skills," he recalls. "We are hopeful that the quality standards we are used to supplying will be transferable to the nuclear industry."

Constant improvement

After learning about Fit For Nuclear from a contact at the Manufacturing Advisory Service, the Syspal team completed the initial online self-assessment in August 2016. "We had a little bit of work to do," Truman notes. "F4N is very different to our general quality standards – it's more of a continuous journey. The first assessment is about saying you're capable of doing work for the sector, but you need to keep improving in various areas. The constant improvement is the important thing for us."

Driving those improvements was the responsibility of QHSE manager Ray Hoffman. "We've made a lot of progress in the past two and half years – we took on board all the advice, and our directors headed up the plan, committing resources to do what we needed to do," Hoffman says.

Syspal's rigorous approach to design and manufacture meant that the production side of the business easily met F4N standards, but the assessment did highlight room for development in areas such as organisational structure, strategic management and performance measurement.

Hoffman was supported by John Olver, one of the Nuclear AMRC's team of regional industrial advisors, who regularly visited the factory to make sure Syspal's journey was on track.

"John has seen our progression over the past two and half years," Hoffman notes. "He was a tremendous help throughout the process, particularly in linking us up with F4N-granted companies to support our supply chain."

The F4N process has helped raise the awareness of quality systems even higher

across the business. Syspal already had a host of qualifications including OHSAS 18001 for health and safety, ISO 9001 for quality management and ISO 13485 for medical devices, and is working towards ISO 14001 for environmental management. "Out of all of these, F4N was at a different level," Truman says.

Digital advantage

Alongside its F4N journey, Syspal has continued to invest in digital manufacturing technologies to improve efficiency and customer service.

"We have digital processes throughout the business from design onwards – there's no drawings on the shop floor, everyone involved in production has access to the necessary information on screen," Truman says.

Syspal has developed its own software to create a full bill of materials direct from the CAD model. Combined with work instructions from the material requirements planning system, that provides a seamless transfer of information from design to manufacture.

"If the model's right, we can simulate all the parts to make sure we can make them before we take any metal out of the stores, and we know they'll be right first time when they come off the machines," Truman says.

Syspal was the first fabricator in the UK to use a tube laser cutter and, more recently, the first to introduce LVD ToolCell press brakes for sheet metal working. With advanced features including automated tool changing, the machines have more than doubled productivity compared with manual presses. "We've deskilled some operations which traditionally required highly experienced operatives, by changing our processes and procedures and facilitating right-first-time production," Truman says.

The firm continues to invest in new capabilities and facilities, with a major expansion of the workshop underway to separate fabrication from final assembly and provide room for larger jobs.

Opportunities to clean up

Syspal's challenge now is to secure a first significant contract in the nuclear market, and build the relationship for long-term work in the sector.

"We are not just looking for one-off projects, we really want new challenges we can plan for and resource properly," Truman says. "You can't resource things that just come and go. It's really important to see some progression when we can invest resources to build additional skills. We're not afraid to invest in people, processes and training."

Truman sees the biggest opportunities in decommissioning. Many of Syspal's product lines for the food processing industry – including decontamination facilities, access control systems and container handling systems – have close equivalents at decommissioning sites, and the firm also has the subcontracting expertise for demanding bespoke projects.

"We need to engage with companies in search of highly experienced stainless steel or aluminium fabricators with dedicated facilities for non-ferrous metals," Truman says. "It might be a degassing chamber, it might be a glovebox. Our goal is to find a partner that's completely focused on this industry, and become their partner in the supply and development of such products."

As a first step towards understanding of the needs of the decommissioning market, Truman attended an information day with supply chain specialists from Sellafield Ltd, organised by the Nuclear AMRC in July. The event was "most enlightening", he says.

www.syspal.com

www.manifab.com

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.

Capula is an independent integrator of control, automation and operational intelligence systems for nuclear and other industries.
www.capula.co.uk

James Walker UK supplies high-performance fluid sealing products and associated knowledge-based services to virtually every sector of industry.
www.jameswalker.biz

R-Tech Materials provides specialist materials testing and consultancy services across a range of industrial sectors.
www.r-techmaterials.com

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

Abbey Forged Products

CPE

FLI Structures

Fan Systems, part of Witt UK Group,

Helander Precision Engineering

Hosokawa-Micron

HV Wooding Ltd

Laker-Vent Engineering

Ledwood Mechanical Engineering

SST Technology

Swagelok Manchester

Westbury Park Engineering

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

Nuvia wins health & safety honours

Nuclear engineering group Nuvia has been given the highest award from the Royal Society for the Prevention of Accidents in recognition of its commitment to health and safety management and continuous improvement.

Nuvia, a tier one member of the Nuclear AMRC, won the 2019 Sir George Earle Trophy – the premier performance award for occupational health and safety – as well as the Engineering Services Sector Award for the fifth time.

The judges praised Nuvia's approach to innovation, and noted its strong focus on consultation and engagement with the workforce as key to its success. The judges also recognised Nuvia's investment in schools engagement and the opportunities given to apprentices and new recruits for personal and professional development.

"This award is for everyone at Nuvia: our staff, our contractors and our supply chain," said Nuvia CEO Keith Collett. "It shows that the actions and attitudes of all our people towards safety, health and environment have created the kind of culture we first talked about a decade ago."

Nuvia is the nuclear division of Soletanche Freyssinet, a world leader in specialised civil and geotechnical engineering, and a wholly-owned subsidiary of construction group Vinci.

www.nuvia.co.uk

Concrete achievement at **Hinkley Point C**

EDF Energy's nuclear new build project at Hinkley Point C has hit its biggest milestone yet on schedule.

The completion of the base for the first reactor – a milestone know as J-zero – means that construction of the nuclear buildings above ground can now begin in earnest.

The final 9,000m^3 of concrete was the largest concrete pour in the UK, beating a record set by the Shard in London. Reinforced with 5,000 tonnes of Welsh steel, the base was constructed by the UK-French joint venture of Bouygues-Laing O'Rourke over six months.

EDF also announced that it had signed final contracts to install pipes and cables at the power station, with a joint venture of Cavendish Nuclear, Balfour Beatty, Altrad and Doosan Babcock. The collaboration was influenced by the success of a single organisation carrying out this complex work during construction at Taishan, the EPR reactor now operating in China.

"I am proud of the talent and achievement of our diverse UK workforce, our unions, our international supply chain and the design team in France," said Stuart Crooks, EDF's managing director for Hinkley Point C. "We are benefitting from direct experience from other EPR projects and a partner in CGN which understands the technology and the project."

The construction of the second of Hinkley Point C's two 1.6GWe EPR reactor units is well underway, and on track to hit its own J-zero in June 2020. EDF says its progress shows the improved efficiency possible when an identical design is repeated, with the 12-month separation offering maximum efficiency for the transfer of teams between units.

An engineering **adventure**

Nuclear AMRC researcher Matt Smart visited Japan to present the Simple project (see p4), and took the opportunity for the journey of a lifetime. He explains how engineering research can open new horizons.

During my time at the Nuclear AMRC, I have had great opportunities for travel. As well as regularly visiting companies and Catapult centres around the UK, I have travelled internationally to various academic and industrial conferences.

In May, I visited Japan to present the Simple project at the 27th International Conference On Nuclear Engineering in Tsukuba, near Tokyo. This event was fantastic for my professional development, and to understand the challenges and innovations in Japan and the global nuclear industry.

Having these opportunities for travel is one of the many benefits of working at the Nuclear AMRC. Following the conference, I was able to book some annual leave and have a bit of an adventure. As well as my usual luggage, I flew my bike out to Japan and spent three weeks cycling from Hiroshima to Sendai. I covered a very hilly 2,100km and ascended over 36,000m, which isn't too bad given I had all of my luggage and camping gear on the bike.

Throughout Simple and its sister project Inform, the team at Nuclear AMRC have presented at conferences in Prague, Bratislava and Texas. I would encourage any engineer, especially those at an early stage of their career, to put themselves forward to present their work at these kind of events. Sharing knowledge and building new working relationships is just as important to innovation as the technologies we develop.

Conference wind-down: Matt Smart took the opportunity to cycle through Japan.

Diary namrc.co.uk/news/events

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

EIC Connect Energy2019

10 September, Manchester

The Energy Industries Council's flagship event brings together the supply chain with global leaders in nuclear and renewable power. Nuclear AMRC CEO Andrew Storer will lead the panel discussion on the future of nuclear new build.

www.the-eic.com/EICConnect/EnergyUK

Mattear seminar

17 September, Sheffield

The Mattear project, led by Wood as part of the Nuclear Innovation Programme, is developing manufacturing technologies for the next generation of nuclear power. The Nuclear AMRC hosts this industry event to share and discuss the latest research.

namrc.co.uk/events/mattear-sept19

Engineering & Technology Solutions Exhibition

25 September, Birchwood

The UK's biggest independent nuclear suppliers' exhibition returns to Birchwood Park for networking, tech demonstrations and more.

www.nuclearexhibitions.com/BirchwoodEvent

Nuclear South West Conference

2–3 October, Bridgwater

With a theme of bringing innovation to nuclear, this two-day event highlights regional opportunities in new build, decommissioning, defence and new technologies.

nsw2019.eventbrite.co.uk

NIA Nuclear 2019

5 December, London

The Nuclear Industry Association presents the UK industry's leading annual nuclear conference, now in its 19th year. The event covers nuclear new build, decommissioning, export opportunities, skills and more.

www.niauk.org/event-listing/nuclear-2019

Work **with us**

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

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

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

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

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

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

To find out more about how we can help your business, contact Jay Shaw, Nuclear AMRC Programme Director: jay.shaw@namrc.co.uk

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Tier 1 members:

CAMMELL LAIRD · Canadian Nuclear Laboratories · cavendish nuclear · EPRI ELECTRIC POWER RESEARCH INSTITUTE · framatome · HEXAGON MANUFACTURING INTELLIGENCE · ITW Welding · NDA Nuclear Decommissioning Authority · NIA Nuclear Industry Association · Rolls-Royce · SHEFFIELD FORGEMASTERS INTERNATIONAL · TSP ENGINEERING · Ultra ELECTRONICS · Westinghouse

Tier 2 members:

AMI · ATLAS COMPOSITE TECHNOLOGIES · AUTODESK · CENTRONIC · CURTISS-WRIGHT · DANOBAT · HOUGHTON · IFA Independent Forgings and Alloys · IMS SOFTWARE · ARGYLL RUANE · JOHNSON & ALLEN · MAHER · The National Skills Academy NUCLEAR · NIKKEN · NUVIA · POLYSOUDE THE ART OF WELDING · pro beam · Red-D-Arc Weld Automation · SANDVIK Coromant · SolidCAM · SOUTH WEST NUCLEAR HUB · starrag Starrag Group · TBT TIEFBOHRTECHNIK · TVC · VIRTALIS CONNECTED IMMERSIVE VISUALISATION · WARD CNC · WB ALLOYS

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