NUCLEAR AMRC

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Modular manufacturing uncovered

Birkenhead R&D facility opens for business



Modularisation research facility opens for business

The Nuclear AMRC has opened its new modular manufacturing R&D centre, at the Birkenhead site of member company Cammell Laird.

The opening marked the start of a research collaboration led by Cammell Laird to develop modular manufacturing techniques to support the UK's nuclear new build programme.

The new facility extends the Nuclear AMRC's process development capabilities into modular manufacturing. Modular manufacturing involves the off-site assembly of large-scale complex systems, which are then transported to site for final installation.

Modular techniques are already widely used in shipbuilding, aerospace and other safety-critical industries. In the nuclear sector, they can significantly reduce construction risk and help deliver new power stations to schedule and cost.

The Nuclear AMRC Birkenhead facility was officially opened on 4 July, with a launch event attended by around 50 industry delegates.

The event featured presentations from Jonathan Brown, managing director for energy at Cammell Laird; Craig Lester, executive director for nuclear strategy at the Department of Business, Energy & Industrial Strategy (BEIS); Dick Elsy, chief executive officer for the High Value Grand opening: around 50 industry guests attended the Birkenhead facility launch event.

Manufacturing Catapult; and Andrew Storer, managing director of the Nuclear AMRC.

With over 1,000m² of workshop space, the new facility will host specialised machining, joining and assembly equipment to develop and prove modular manufacturing techniques for nuclear applications. Work will address modular manufacturing for new reactors of all sizes, as well as the challenges of decommissioning and waste management.

"Our new Birkenhead facility extends our capabilities into an area of huge interest and importance to the nuclear industry," said Storer. "Modularisation reduces risk in manufacturing and construction, and will help developers build new power stations on schedule and on budget, meeting our national targets for secure, cost-effective, low-carbon electricity generation.

"The manufacturing techniques we will develop at the new facility can also help improve production efficiency and costs in other parts of the nuclear market, for example in the manufacture of large numbers of standardised waste boxes for the decommissioning programme.

"Our Birkenhead facility is the first of a new network of regional supply chain hubs, which will help us provide on-the-ground support to companies of all sizes across the UK. Birkenhead is ideally placed for the established nuclear cluster in North West England as well as the Wylfa new build site in North Wales. We want to help companies based in this region to become Fit For Nuclear and win work in the nuclear sector at home and worldwide."

The Nuclear AMRC Birkenhead facility is hosted by Cammell Laird, which joined the Nuclear AMRC as a tier one member earlier this year. Cammell Laird's 120acre site on the Mersey features four dry docks, a non-tidal wet basin, a large modular construction hall and extensive covered workshops. The company has been involved with the UK's nuclear sector for a number of years, and is positioning itself as a world-leading hub of modular manufacturing expertise.

Cammell Laird is now leading a new modularisation research project with funding from BEIS through the Small Business Research Initiative.

The project, called Fit For Modules, aims to develop the UK supply chain into a world-leading provider of modular manufacturing techniques for nuclear and other high-value energy sectors. The project consortium – including the Nuclear



Launch team: (L-R) Jonathan Brown of Cammell Laird; Craig Lester of BEIS; Dick Elsy of the High Value Manufacturing Catapult; and Andrew Storer of the Nuclear AMRC.

AMRC, Laing O'Rourke, Arup and Frazer-Nash Consultancy – will work with industry and regulators to map the challenges and opportunities of modularisation.

"Modularisation is widely applied on shipbuilding, civil construction and a number of other sectors where it is demonstrated to bring significant benefits in terms of cost reductions and improved schedule performance," said Brown. "We are confident that when applied correctly within the nuclear sector we will see similar benefits."

The first stage of the project will produce a detailed study showing how the development of modular techniques can support the UK's nuclear new build programme, and identifying what research and investment are needed to turn the UK into the world leader in off-site modular construction for the nuclear industry.

Immediately after the opening of the R&D facility, Cammell Laird hosted a two-day industry workshop to discuss modularisation challenges associated with process and methods, technologies and techniques, and people and culture.

More than 20 companies took part in the workshop, including reactor providers Westinghouse and NuScale Power, Rolls-Royce, Urenco, Amec Foster Wheeler, and manufacturers along the supply chain, as well as academics and representatives from BEIS and the Office for Nuclear Regulation.

The project will also consider financial and supply chain issues around modularisation.

At the end of the first year-long phase, the consortium will publish a technology roadmap detailing how the required technologies and capabilities can be developed over the next five years. The report will be shared with industry, including more than 120 manufacturers which have completed the Nuclear AMRC's Fit For Nuclear (F4N) supplier development programme.

"Our Birkenhead facility is the first of a new network of regional supply chain hubs, which will help us provide on-the-ground support to companies of all sizes across the UK."

Andrew Storer, Nuclear AMRC.

Chattering robots needn't cause stress

Chatter vibrations from robotic machining platforms affect surface integrity less than feared, Nuclear AMRC researchers have shown.

Can potentially reduce the cost of machining work on pressure vessels by 80%

The Nuclear AMRC is leading research into the use of portable robotic systems which can carry out a range of operations on large and unwieldy components and assemblies for the nuclear industry. Conventionally, producing very large metal components requires correspondingly large machining centres. Initial studies by the team have shown that the lower capital cost of portable robotic systems, compared with gantry machines, can potentially reduce the cost of machining work on pressure vessels by 80 per cent.

This "process-to-part" approach is already used in industries such as aerospace, oil & gas, marine and wind energy, typically for machining features which do not require the highest levels of precision. For large nuclear vessels, robotic machining can potentially be used to mill, drill and tap features such as weld preps, nozzle opening profiles, pipe/vessel facing and holes.

However, robotic systems have much less dynamic stiffness than machining centres, which makes them more prone to a type of vibration known as chatter. This can affect the surface integrity of the machined component, increasing the risk of corrosion cracking or other material failure during its operational life.

To better understand the effects of chatter in robotic machining, Nuclear AMRC technical lead Dr Agostino Maurotto led a study of the effects on surface integrity of stable, mild and severe chattering conditions. The project focused on dry milling of small coupons of the nickelbased superalloy Ni-690, using cermet (ceramic/metal) inserts from member company Sandvik Coromant. Alloy 690 is considered a difficult-to-machine metal, and is widely used in nuclear steam generator tubesheets and other missioncritical components.

The project used a robotic machining cell based around a Fanuc F200i hexapod robot

Six legs good: researchers used a flexible hexapod robot platform.

platform carrying a 8kW Gamfior machining spindle.

To understand the nature of the chattering, the team recorded vibration and sound data using accelerometers and acoustic microphones. They then investigated the effects of different cutting conditions on residual stress, surface roughness, and tool wear.

Unexpectedly, the analysis showed that surface residual stress and roughness remained similar under all cutting conditions.

"I was quite surprised that the workpiece surface roughness remained acceptable," says Maurotto. "Residual stress is always difficult to predict but I would have expected it to increase during chattering. In fact, there were only minor changes between tool mode chattering and nonchattering conditions."

Residual stress did increase when the entire robot body, not just the tool, suffered chatter vibrations, but avoiding this condition was relatively simple. Tool damage during chatter was surprisingly minor, although it did increase when moving between stable and unstable cutting conditions. "I was quite expecting to observe catastrophic tool damage during chattering – as cermet tools are very sensitive to vibrations, I was expecting the inserts to be quickly damaged, but they weren't," Maurotto notes.

Maurotto presented the research at the ASME pressure vessels and piping conference in Hawaii in July.

The work was part of the Nnuman project, an £8 million, four-year EPSRC-funded programme led by The University of Manchester's Dalton Nuclear Institute. Maurotto is now planning to extend the study on larger and more representative workpieces, to investigate chattering effects when using minimum quantity lubricant (MQL) and different machining strategies.

For more information about the Nuclear AMRC's research into machining and surface integrity, contact: a.maurotto@namrc.co.uk

Robot machining cell at heart of European collaboration

Nuclear AMRC engineers have started work with a new robotic machining cell as part of a €6 million European project to develop intelligent robots for nuclear manufacturing and other industries.

The team are investigating whether the ABB 6700, a large industrial robot arm with six degrees of freedom of movement, can provide the positional accuracy and repeatability required for machining tasks. The project will initially focus on finishing operations such as grinding, deburring and finish milling.

"To the best of my knowledge, no research centre has ever done a robotic machining project at this scale before," says Ozan Gurdal, Nuclear AMRC research engineer. "The components are actual nuclear components, and material is nuclear-grade material. The robots developed by the Coroma project will also have cognitive abilities for operations such as part scanning and toolpath generating, so we will be bringing real innovation to robotic machining."

The arm will initially carry an 8kW spindle, with additional end effectors to be introduced and tested through the project. The cell also features a range of laser-based and tactile metrology and dynamic testing equipment.

The work is part of the Coroma project, an international R&D collaboration involving 16 partners from seven countries, which launched in late 2016. The three-year, $\in 6$ million project is funded through the European Horizon 2020 programme, and led by Spanish research group IK4–Ideko.

Coroma aims to develop cognitively-enhanced modular industrial robots which can perform a range of manufacturing tasks with minimal input from humans. Potential benefits include reduced set-up and costs, and improved adaptability of manufacturing systems.

The Coroma partners are developing a series of innovative robotic modules which focus on areas including safety, robot-machine interaction, advanced grasping and manipulation technology, 3D vision, automatic path programming, robot mobility and process monitoring, and optimisation through self-learning.

The Nuclear AMRC is working alongside its sister centre, the AMRC with Boeing, on innovations including intelligent fixturing, mobile fixturing for large thin-walled parts, and machining tools.

The technologies will then be integrated in a series of industrial demonstrators for aerospace, naval and nuclear applications. The Nuclear AMRC will work with Spanish nuclear manufacturing group Equipos Nucleares SA (Ensa) to demonstrate applications for large reactor components, with the team combining a range of techniques developed across the project on the Nuclear AMRC's Soraluce FX12000 machining centre.

In July, Coroma researchers from across Europe visited the Nuclear AMRC to view the new robotic cell and Soraluce platform. The visit was part of a project workshop on module integration held at the AMRC Knowledge Transfer Centre.

www.coroma-project.eu



Electron beam could slash time for waste container fabrication

The Nuclear AMRC has completed the first trials of welding a large waste container using its giant electron beam facility.

The work is part of an ongoing research programme with Sellafield Ltd to improve production of the standard 3m³ waste container.

Tens of thousands of such boxes will be required over the next 30 years to store intermediate-level waste from Sellafield and other UK decommissioning sites.

The full-size box used for the welding trial was constructed of 6mm thick plates of



Box fresh: Dr Bernd Baufeld inspects the welded container.

duplex 2205 stainless steel. The plates were tacked together by manual arc welding before going into the Pro-Beam K2000 electron beam welding facility. With a vacuum chamber volume of 208m³, the K2000 is the largest facility of its kind in the UK. It also boasts advanced features including an internal wire feeder system which is essential for achieving the required mechanical and corrosion properties in duplex steel welds.

Welding each side took less than five minutes. Electron beam welding offers quality improvements as well as time savings, notes technology lead Dr Bernd Baufeld – electron beam welding takes place in a vacuum, so there is no risk of oxidation.

Allowing for set-up, evacuation and welding, one electron beam chamber could weld three boxes in a single shift, Baufeld estimates.

The Nuclear AMRC is investigating a number of routes to improve manufacturing of the current design of 3m³ containers. Researchers have studied



a range of automated welding techniques, and will next investigate laser welding using the centre's new 16kW disk laser facility, to be commissioned by the end of this year.

Nuclear AMRC engineers have also developed automated inspection techniques for the containers, and worked with AMRC Castings – part of the University of Sheffield's AMRC with Boeing – to produce the top lid flanges by casting instead of machining. The Nuclear AMRC machining team are now investigating how the cast part can be finished to the final precise specifications, while maintaining geometrical accuracy and surface integrity.

The Nuclear AMRC is also leading the integrated innovation team on waste containers for Sellafield Ltd, to investigate a range of advanced manufacturing techniques, materials and design concepts which could further improve production efficiency for the next generation of waste containers.

To find out more about the Nuclear AMRC's electron beam capabilities, contact: bernd.baufeld@namrc.co.uk

Versatile approach to decommissioning tasks

The Nuclear AMRC is working with industrial design specialist Eadon Consulting to develop a new system to tackle complex decommissioning challenges.

The project aims to develop a versatile decommissioning system which will use laser scanning and computer-based modelling to accurately plan a variety of complicated engineering tasks.

Eadon, based alongside the Nuclear AMRC on the Advanced Manufacturing Park (AMP) in South Yorkshire, is leading the project with funding from the Nuclear Decommissioning Authority and the Small Business Research Initiative, managed by Innovate UK.

"As a small company of specialist engineers, we are ideally placed to solve

problems – our size allows us to innovate and quickly develop new ideas," says James Hill, director at Eadon Consulting.

"Collaborating with other companies means that we can tap into a wealth of knowledge and experience from lots of different industries and pick out all the most useful bits. Our immediate focus is on decommissioning the nuclear site at Sellafield, but the systems we are developing have huge potential for export all over the world."

The research collaboration includes the Nuclear AMRC; Cammell Laird; RED Engineering, a Newcastle-based engineering specialist which has recently been granted Fit For Nuclear status; Westlakes Engineering, a Whitehavenbased consultancy; and PES Engineering, a

scanning and data manipulation specialist which is also based on AMP.

The Nuclear AMRC will develop a novel decommissioning tool which will use a laser cutter to slice small-bore pipework into the optimal length for storage, then crush the sections to reduce the volume of waste.

In the initial three-month phase of the project, the consortium will develop concept designs for new equipment and explore new techniques for planning and visualising decommissioning tasks. If the approach proves fruitful, Innovate UK will release additional funding to develop full working prototypes and begin trials.

www.eadonconsulting.co.uk

Boxing clever: Amber Precast managing director Mark Johnson, Magnox projects programme manager Gary Ward, and DavyMarkham nuclear and defence director John Cheek, with a prototype 6m³ waste container mould.

Amber Precast

£20 million

Magnox work for DavyMarkham

The Nuclear AMRC's newest member company has secured a £20 million contract to produce waste containers for Magnox.

Sheffield-based heavy engineering specialist DavyMarkham will work with its sister company, Amber Precast, to design, test and construct transportable 6m³ concrete containers for intermediate-level waste (ILW) from the Magnox reactors. DavyMarkham is creating a new dedicated plant and up to 50 jobs at its site in Darnall to carry out the work.

"Being awarded this supply contract for concrete ILW containers is a step forward for DavyMarkham in its drive to become the UK leader in providing high integrity containers to the nuclear industry," says Bill Clark, DavyMarkham managing director.

"It's good to see the government and the Nuclear Decommissioning Authority supporting strategic UK manufacturing companies which benefit the UK's nuclear decommissioning industry as well as securing UK jobs. Importantly, it also provides UK manufacturers export opportunities with overseas buyers who are looking for innovative highintegrity products in support of safe decommissioning." The four-year contract will draw on DavyMarkham's expertise in high quality steel fabrications for container casings and handling features, and the precast concrete capabilities of Derbyshire-based Amber Precast. Both firms are part of the Hughes-Armstrong Industries group.

Once the final design and manufacturing methodology have been approved, Magnox will require more than 1,000 of these 6m³ boxes to store various types of intermediate-level waste from the operational and early decommissioning phases of its UK power stations.

With a history going back to 1830, DavyMarkham is a leader in the design, manufacture and assembly of large equipment for mining, power generation, oil, gas and nuclear sectors. Since Clark led a buyout of the company in 2014 alongside Hughes-Armstrong, DavyMarkham has increasingly positioned itself at the top end of the manufacturing technology spectrum.

The contract comes as DavyMarkham joins the Nuclear AMRC as a tier two member.



"Membership of the Nuclear AMRC demonstrates DavyMarkham's commitment to participating in the nuclear supply chain through collaboration and innovation with key strategic partners," says Dr Alan Thompson, director of quality at DavyMarkham.

"We will work with the centre's engineers and partners to create production routes where technological developments and manufacturing excellence will deliver the required quality at an acceptable cost, and extend our research programme to reduce costs and manufacturing lead times."

DavyMarkham works with nuclear customers including Sellafield Ltd, AWE and Rolls-Royce. The firm completed the Fit For Nuclear programme in March 2016, and appointed industry veteran John Cheek as nuclear and defence director in October.

www.davymarkham.com

New CEO focuses on performance

Andrew Storer has been appointed chief executive officer of the Nuclear AMRC, with effect from 1 August. He succeeds Mike Tynan, who is retiring after four years leading the centre and 42 years in the nuclear industry.



Stepping up: Storer becomes chief executive after two years as managing director.

Andrew has provided day-to-day leadership as managing director of the Nuclear AMRC since 2015. *Nuclear AMRC News* asked him to introduce his vision for the centre.

I have been at the Nuclear AMRC since October 2015, but I've been involved since the beginning. I was programme director for Rolls-Royce's civil nuclear business, and we needed somewhere to develop manufacturing techniques to help deliver potential contracts.

Back in 2012/13, the centre was dominated by one customer responsible for 85 per cent of work. Those early years were about creating the physical assets and starting to think seriously about supply chain support.

Since then, Mike Tynan has spent a lot of time and effort getting the Nuclear AMRC into the fabric of the nuclear industry. Within the past year, we have diversified the customer base so we are no longer dominated by any one company, while increasing overall revenue. We have opened a new centre in Birkenhead for modules and local supply chain support. We are really well engaged with Sellafield, and see this as a great relationship for the future.



We still have a lot more to do. More than ever, the UK nuclear industry needs to work as one, building on the good things across the sector and not just reinventing everything in silos. Consolidating procurement plans across the sector would help us all understand volumes, stimulate UK investment, and leverage economies of scale. Research needs to be targeted at today's scope of work as well as future needs, to help companies make things at lower cost and with greater repeatability while meeting quality demands.

This efficiency needs to be fed back to the consumer – nuclear is competing with other energy sources and we can't take anything for granted. We must start by showing that we can deliver current programmes in new build, decommissioning and submarines, and keep generating 21 per cent of the UK's electricity at EDF's 15 operational reactors.

To support this cross-sector approach, we are working with the Nuclear Industry Association (NIA) to develop a sector deal as part of the new industrial strategy. This is one of five initial deals proposed by the secretary of state, Greg Clark, and was presented at the Nuclear Industry Council (NIC) in July. This is a once-in-a-generation chance to positively change our sector, with some real game-changing topics which were all agreed as sensible areas for development.

The new energy minister, Richard Harrington, and his team are now working with NIC members to develop the details for presentation to Clark later this year. We hope this will trigger new approaches for current and future technology development and intellectual property in the UK.

So what does all this mean for Nuclear AMRC? We are now in the performing phase of the centre's life. We intend to deliver more in-depth supply chain development, providing very specific support to companies against real opportunities. This will link back to our facilities in Rotherham and Birkenhead, providing more tangible disruptive manufacturing research based on industry pull as well as innovation push. We also plan to develop bases in the UK's key nuclear regions, providing localised support to reduce the burden on the supply chain.

There's nothing in our name to say we only work with metal – we intend to develop our research into electrical controls and instrumentation, which make up a large part of the value of a reactor plant and which fall within UK scope.

We recognise that qualification of equipment is a vital part of UK companies winning work, and are working very closely with the Office for Nuclear Regulation (ONR) to provide additional support for this and other areas. And of course, we will develop our work on modules, which we see as fundamental to reducing cost, and which we are just starting to address at our new facility.

We have lots to do at the Nuclear AMRC and, as the new chief executive, it really does excite me. I look forward to continuing to work with everyone here at the centre and all our members, partners and friends in the nuclear industry.

namrc.co.uk

F4N masterclass: maintaining excellence

Fit For Nuclear is a journey of business improvement – but being granted F4N doesn't mean that you've reached your destination. Fit For Nuclear

Supply chain specialist: Martin Ride presenting at an F4N event.

Winning business in the nuclear sector will require continuing commitment and drive to maintain and develop standards. This autumn, the Nuclear AMRC will launch a major expansion of the F4N programme to provide ongoing targeted support to help companies identify opportunities and win work after granting.

As a taster, supply chain specialist Martin Ride presents his 12 top tips on sustaining business excellence, and five F4N companies reveal how they've maintained momentum and won new work.

Since we launched Fit For Nuclear in 2011, we have aimed to retain a very clear and strong focus on business excellence. More than 600 companies, with a combined turnover of over £10 billion and employing close to 400,000 people, have taken the initial online assessment. More than 120 have completed the basic programme and been granted F4N.

For most of these companies, F4N has been an integral part of their journey towards winning work or securing new contracts in the nuclear market. For some, it has served to check that they really are where they thought they were, whether new to the market or longserving suppliers. While there has been a host of success stories, many companies are still on the journey to their real first order. Regardless, the key to success is maintaining and developing your standards, and continuing to drive further improvements.

Our vision is that each and every company on the F4N programme can go out to attract new nuclear customers and win orders. We are often asked about the reality of winning orders, and we have to be honest – F4N does not and cannot guarantee new work for any participating company.

What F4N will do, however, is remove inherent risks and hazards that would present a stumbling block to nuclear buyers. It will also greatly assist with your preparations for client company assessments, audits or re-assessment, which is the point where any company needs to demonstrate its strengths and be at its best.

Having spent a lifetime working in the

nuclear supply chain, I am able to provide a steer on what nuclear buyers will expect of you. Much of this has already been built into the F4N programme, so working through your F4N assessment report – however painful or rewarding this might be – is a fundamental starting point. Taking hold of your programme action plan, and really committing to it from the top down, is literally your plan for success.

Being granted F4N is but the first part of your journey. The next part is where the real and much more challenging work has to start. This is about sustainability and your approach to continuing and ongoing improvement post-F4N. Your F4N industrial advisor will guide you, but I would emphasise that doing nothing after F4N granting should not be an option.

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The following 12 points are my top tips and guidance for driving continued business excellence after being granted F4N.

Some points you may recognise and already appreciate, some you may not. Either way, your industrial advisor and the F4N team will be here to keep you on track and support you through your continuing journey of winning work in nuclear and beyond.

advisor track and of winning

Martin Ride is the Nuclear AMRC's lead consultant on the nuclear supply chain. He has over 30 years'

industrial experience as a nuclear specialist with companies including Rolls-Royce, and has worked on the F4N programme since its launch. martin.ride@namrc.co.uk

Embrace safety culture

You will know that health, safety and environmental (HSE) considerations form one of the fundamental starting points of F4N, and will have addressed this through your business excellence assessment and nuclear checklist self-assessment.

Take a fresh look at your self-assessment – test yourself on just how your safety ratings can really be demonstrated.

You need to show that everyone in your organisation is personally responsible

for safety, and that they fully appreciate this; and that the leaders demonstrate their commitment to safety. You should cultivate a questioning attitude, embrace organisational learning from experience, and ensure that all decision-making reflects a safety-first approach.

Question yourself and your team on whether you really are where you think you are and need to be, with regards to your people, visitors, customers and facilities. Check your risk assessments, and carry out regular shopfloor walkarounds with a single-minded focus on HSE. Make sure that you can demonstrate what you do to your customers.

If you have doubts, ask your industrial advisor – do not assume anything or take any aspect of HSE culture for granted. Nuclear manufacturing has special and unique demands for HSE, and you need to show your commitment.



Understand quality grading for nuclear

Companies with a track record in nuclear will be familiar with the concept of graded quality, but it can be a challenging issue for companies which have not worked in comparable sectors.

Quality grading is an approach to quality assurance where different requirements apply to different products, depending on their end use and their potential impact on nuclear safety and environmental and statutory requirements. Essentially, the greatest quality control is applied where the risk and impact are greatest.

You should take time to gain an appreciation and understanding of nuclear sector quality grading, and what it means to your company. There is an abundance of good material online from professional institutions, training and skills organisations, and industry trade bodies. Your industrial advisor can direct you to appropriate material, and help explain and interpret what it means for your company. This is a good task for your company's quality manager to work on, with our help as needed.

3

Understand what SQEP means for your company

SQEP is a common bit of nuclear terminology referring to suitably qualified and experienced personnel. To be considered SQEP, an individual needs to be able to demonstrate professional competence – this must be traceable to a competence matrix, and clearly linked to their role.

Professional competence itself is deemed to be demonstrable knowledge, skills and experience as appropriate to the task or activity being undertaken. It must be supported by formal training qualifications, and ideally be backed up by a documented career development plan.

Key members of your company's team may need to be SQEP to work in nuclear. Having a structured approach, with good records and evidence in place, will make your life a lot easier when you do have to demonstrate SQEP.

Identify the key roles in your company where SQEP demonstration is considered to be important, then put the mechanisms in place.

This will probably include individuals responsible for design, quality and engineering within your company, as a minimum. Your industrial advisor will again be able to guide you and, where necessary, put you in contact with relevant skills bodies.



Aerotech Precision Manufacturing F4N granted April 2016

Since achieving F4N, we've seen a significant spike in activities within the nuclear sector. We have been working with a major tier one supplier on the machining of nuclear carrier parts. The project was initiated following certification, with our client particularly encouraged by our commitment to gaining the industry standard. We have also recently started working with a major government agency on intricate machined parts associated with a major nuclear contractor.

As a result of our increased focus on the nuclear sector, we have invested in both staff and equipment to cater for the increased demands put upon the business. In particular, the enhanced quality requirements have resulted in the need to employ an extra quality inspector. On the equipment side, we have purchased a new state-of-the-art five-axis machine, along with a new large coordinate measuring machine. We have also invested in sophisticated automated inspection technology to reduce lead times.

One of the most significant benefits we have seen since becoming F4N is in our quality processes. As a result of achieving certification, we have also gained ISO 14001 and seen our processes change significantly for the good. Overall staff involvement in the business has improved, with the workforce taking a much keener interest in new projects, attending workshops and participating in staff feedback sessions, leading to improved morale right across the business.

There is also a discernible improvement in the awareness of quality in the manufacturing process – as a result the audit process is better with improved stock control in place.

For the future, we are very positive that our activities in the nuclear sector will continue to grow. We are confident that we now have the systems and processes in place to support an increased sales and marketing effort to other tier ones. We have



already seen the benefits of having the F4N symbol with the quality departments of other clients, outside of the sector. The mark has helped to raise Aerotech's profile, introduced a higher level of discipline across the business, and has opened up opportunities that we previously would not even have considered.

Allan Redfern, sales director aero-tech.co.uk

4

Define your organisational structure

Having a clearly defined and wellunderstood organisational structure in place might seem to be an odd tip, but the subject comes up in many industry codes and standards. Organisational structure can be linked to aspects of nuclear sector regulations. If you do not have an organisational structure in place, or have not shared it with your employees, then now is the time to act.

Ensure that there is a well-documented organisational structure in place showing roles and responsibilities. Make sure that it is deployed across your company, is maintained as part of your management system, and is included as part of any

induction briefing for new employees and contractors.

Be prepared to share your structure with nuclear customers, when asked. Depending on quality graded work being undertaken, customers might expect to be made aware of any changes to your organisation.

5

Test your compliance with the guiding principles

Common working principles apply right across the nuclear industry, flowing from the site licence companies down through the supply chain.

From a long list of principles including nuclear safety and intelligent customer obligations, some are worthy of particular attention:

- Suppliers shall understand and apply the principles of configuration management.
- Suppliers shall understand and operate robust change control processes.
- Suppliers shall understand and operate robust non-conformance control and containment processes.
- Suppliers will operate transparently and share information, including lessons learned and discovery of counterfeit, fraudulent and suspect items (CFSI).

Consider these principles and test your ability to demonstrate adherence and compliance with them at all times.

Your audited ISO 9001 management system will consider most if not all of these principles, but to excel in nuclear you should really challenge yourself. Your industrial advisor will be able to help.

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Work together

The UK nuclear industry has put a strong emphasis on the principle of working together. Companies along the supply chain are encouraged to develop strong relationships, mechanisms to identify performance improvement opportunities, approaches for preventing concerns, and effective resolution tools for customers

and suppliers.

Re-examine whether you can confidently demonstrate open and honest communications, shared learning, continuous improvement, and a structured approach to problem solving throughout your operations. These practices affect customer and supply chain flow-down requirements, and can be a real challenge to demonstrate. Many companies will have robust policies in place through ISO 9001 accreditation, but you will receive long-lasting rewards from reviewing how you have embedded the principle of working together.



6

Understand the importance of pre-contract activities

In nuclear, what happens before a contract is awarded is extremely important. Site licensees have regulatory obligations to ensure that contracts are fully understood before letting, and this applies to all tiers in the supply chain.

Risk management and nuclear safety assurance are at the heart of pre-contract activities. You may be asked to complete pre-qualification, information request and other early tendering activities – these will vary between organisations, but the common purpose is to allow the buyer to understand contractor capabilities and associated risks before they make contracting decisions.

Pre-contact activities can be time consuming, but will ensure that there is a satisfactory understanding of, and ability to meet, buyer specification and contractual/ commercial requirements before a contract is awarded. These activities can be two-way – if you are closing in on an order, use them to check on your own understanding.

You need to embed an understanding of what pre-contract activities are

for. You should define a standardised approach, and embed your capability and operational details in readiness for precontract activity engagements. You will benefit from this downstream.

You should also adopt the same approach to your own suppliers, by updating your incompany processes and standards for your own contracts. Buyer organisations will be highly supportive of this approach, which will assist with your own risk exposure and contracting obligations. This really is important!

HV Wooding F4N granted February 2016

The F4N programme allowed us to analyse our strengths and potential weaknesses within the business, and how we can work as a company to strengthen ourselves. The visual management and control of our workflow has given new customers the confidence to place work with us, knowing that their expectations will be achieved.



The standards we achieved have been sustained and improved through our strong audit methods and continual improvement system. This strong baseline is helping us make a smooth transition from our other industry standards to meet the latest requirements (ISO 9001:2015, ISO 14001:2015 and ISO 45001). We now challenge our methods and have seen workflow increase with lean methodologies and fully traceable products.

We have added the well-recognised F4N badge to our promotional literature, and this has really elevated potential customers' interest in working with us. We have also seen benefits in high demand for the services we provide and in high levels of engineering candidates who want to work for HV Wooding. This has created a growing business in a market where our competitors of similar size and nature are struggling.

As long as our standards are maintained to a high level once gained, then the opportunities will repeat and grow. For instance, eight years ago we didn't know about working with scientific establishments. We then won a contract to supply machined components for prototype magnets at Cern – now, roughly five per cent of our £11 million turnover comes from supplying universities and science institutes.

Qualifications such as F4N help us to maintain existing business as a sign that we are dedicated to being the best in the industry, and it also gives prospective customers confidence that we are recognised as leaders within our fields of service.

Neal Townsend, operations director www.hvwooding.co.uk



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Be prepared for customer intervention

It shouldn't be a surprise that, once you win a nuclear contract, there may be customer oversight activities and other interventions. Quality grading will influence the extent of oversight, and specific activities will have been identified in the pre-contract stage.

Be prepared for considerable (but proportionate) levels of customer

intervention and oversight activities when working in nuclear.

This may include reviews of quality certifications and accreditations; customer quality plan submissions, approvals and acceptances; and specific manufacturing plans including inspection and test plans. You should also expect reviews of any delivery plan or programme based on what will have been defined during pre-contract activities.

Oversight requirements may also extend through to your own suppliers. Whatever is being applied to you, you should consider extending it through your own supply chain. Managing this will remain your responsibility. If in any doubt, discuss with your industrial advisor.

Control your design process

Not every F4N company will have design responsibilities as part of its scope, but many will. Your design activities will come under scrutiny, and will require robust levels of control. You will need to clearly demonstrate this to prospective nuclear customers, and you will be assessed in detail during pre-contract activities and in future in-contract audits and reassessments. Areas to consider include how you manage design requirements and input/output; the tools and software used; design, manufacture, inspection and test plans; and design control, including change and reviews.

If you have design as part of your capability offering, you should review and challenge your design organisational controls and processes. If you do not have in-house design capabilities but use sub-contract design services to support your operational requirements, you should still review how you control the design process.

continues

Hydrobolt F4N granted January 2014

One of the main projects resulting from F4N is OHSAS 18001, which has resulted in a change of health and safety culture at Hydrobolt. We have an enhanced quality and safety awareness within our facility which is helping us stay ahead of our competitors. Business within the nuclear sector has increased from five to 15 per cent of our annual revenue, and we are now dealing with more "difficult to supply" projects with more prestigious market-leading companies.

We have invested in training and achieved a change of mindset towards customers and their products – employees know where the parts are being used and what our customers expect. We have started a 5S programme on the shopfloor, including a tool vending programme, and IOSH working-safely training for shopfloor managers. We have driven improvements through the company, starting with a company strategy which is monitored on a monthly basis. We set KPIs for each department, and business improvements have been achieved through initiatives such as toolbox talks and maintenance programmes. Customers have visited and audited Hydrobolt and made their own suggestions for improvements.

The most important thing about winning business in nuclear is to get it right first time. If there is any doubt, always ask. Take time to agree upfront what the customer actually wants and expects.

Richard Barnes, business development director www.hydroboltgroup.com



Upgrade your inductions

A robust induction process for your employees and contractors is basic good practice. Nuclear culture means that customers will expect your induction for relevant individuals to cover additional areas including nuclear safety awareness and requirements, mandatory procedures, standards and approvals. Reconsider how well your current approach to inductions and start-of-work briefings meet the requirements of nuclear customers.

If you are already working in nuclear, you should already have robust induction processes in place based on your customers' expectations. Some companies have deployed the nuclear standard on induction across their wider business, as a one-standard approach to safety and best practice. Equally, there are companies which do not work in nuclear but have extraordinarily high standards of induction. Whatever you do, take another look at whether it's as good as it should be.



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Take control of your supply chain

Procurement and sub-contract activities are an extremely important part of any company activity. Anything you procure will represent some level of risk, and you are only ever going to be as good as your supply chain.

Challenge your approach to procurement and purchasing activities. Instead of thinking of a supplier as external, make them integral to your business success. The standards, expectations and performance measures for your suppliers should be at least equal to those of your own internal processes. Think about flowing down your company standards and expectations, addressing most if not all of the points discussed above.

This will mean auditing and regular assessments of your suppliers and their commitment to nuclear safety expectations, transparency and continuing improvement. With nuclear safety (and its regulatory and oversight expectations) as a priority, taking a serious look at your internal procurement and purchasing operations will prove to be a real differentiator for customers, and give you a lasting competitive advantage.

Strata Technology F4N granted June 2016

Since being granted F4N, we have achieved accreditation to Investors In People (IIP) and approval of ISO 14001 and OHSAS 18001 standards. We were already looking into IIP but decided to focus our effort on F4N. However, we recognised that there was significant crossover in the two standards, and achieved IIP accreditation approximately one month after F4N.

We continue to audit ourselves on a regular basis against the requirements of F4N, including the stretch goals. We undertook a staff survey on the sustainability of the requirements of F4N, with very positive results, and key staff members are undertaking nuclear-focused training courses such as the Triple Bar Nuclear Manufacturing and Leadership courses.

While we have not achieved any significant new work to date in the nuclear sector, the F4N standard has helped us build credibility in other sectors which has resulted in Strata securing new work. F4N has fundamentally changed the business and resulted in significant internal improvement in strategic planning, communication and staff engagement throughout the business. We have improved and continue to improve soft skills via appraisals, competencies, training and continued professional development at all levels.

It has also provided us with a vehicle for change – having previously been almost wholly dependent on work from the oil ϑ gas industry, we clearly recognised the need for the business to diversify. We were identifying new target sectors where our skills and capability could be effectively utilised, and the F4N programme provided us with the opportunity for gaining access to the UK civil nuclear sector.

Gaining opportunities to discuss work with key decision makers in the nuclear sector has been difficult to date. We have held discussions with a few tier one and two organisations, but we recognise that timeframes for setting up meetings and



arranging follow-on discussions are necessarily protracted.

It has been great to see the Nuclear AMRC take a more proactive approach in supporting F4N-approved businesses, such as the various nuclear exhibitions during 2017. The civil nuclear industry is very resilient to change, yet it must embrace this if we are to meet our future energy needs and have the infrastructure in place in the UK to achieve this.

Roger Kimber, managing director www.stratatec.co.uk



Amazon Filters F4N granted April 2016

Since being granted F4N, we have been fortunate enough to be able to secure a new contract with Magnox for the manufacture of vent filter assemblies for nuclear waste storage containers. We were chosen following a lengthy evaluation process as we were able to meet quality, production and schedule requirements while also being able to offer a cost saving.

We have also worked with a worldrenowned advanced research laboratory to replace an ageing cooling water ring main filter. Due to the criticality of this application, the new filter housing had to be dimensionally the same as the existing unit. Unable to access or view the filter, as it was shrouded and radioactive, our design team had to use old customer drawings and details from the 1980s to produce manufacturing specifications. Thanks to our expertise in design and manufacturing, we were able to quickly build and supply a bespoke filter housing to meet the exact required dimensions. F4N has formed part of our way of thinking when operating in the nuclear industry. We have attended over a dozen exhibitions promoting Amazon Filters as a F4N company, and wear the badge with pride. As with all our accreditations, we ensure that we continue to maintain the initial standards that afforded us to be awarded F4N, and continue to make improvements to our already robust quality and safety systems.

There can be a lot of upfront work with nuclear-based projects, needing careful time management to ensure that everything is in place before moving onto the next phase. The majority of the work is in fact carried out before the order is placed. We have a proactive culture enabling our experts to guide the customer confidently through the project, from the initial meeting to completion. Designing and manufacturing products on-site affords us flexibility to be able to adapt to situations in a quick and able way, dealing with any



issues as they arise and keeping the project on track.

The biggest benefit we have seen is the credibility that F4N has afforded us. It has certainly opened the door to business for us, as it rubber-stamps our existing capabilities with that industry.

Keith Wickert, technical manager www.amazonfilters.com

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Control your documents and records

If you're already working in nuclear, you will have a well-earned understanding of what documentation and records control really means. It's often referred to as "lifetime records", and is key for any product being considered for use in a nuclear plant. Document control flows through the entire process of production, acceptance, delivery and retention. Products have been taken out of use, scrapped or replaced because of documentation and records issues, at a cost of millions of pounds. Working in nuclear requires you to really understand and demonstrate your ability to manage documentation and records to a very high standard. On top of basic good practice, you may need to become conversant with customer templates and specific requirements, and meet expectations for retention long after contract completion. Your customer order should be clear on this – if not, ask.

Ensure that you fully appreciate customer documentation and record control requirements, and apply these throughout your supply chain.

This will require staff investment, process documentations and ongoing training support, subject to specific requirements for quality grading.

Documentation and records control is an area where companies can run into difficulties if they have limited experience of nuclear, but there are excellent training products available. As ever, your industrial advisor will be able to direct you to appropriate support.

Fit For Nuclear (F4N) helps UK manufacturers get ready to bid for work in the civil nuclear supply chain. **Start your F4N journey: namrc.co.uk/services/f4n**



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



Nuvia wins £20 million contract at Hinkley Point C

Nuclear engineering specialist Nuvia, a tier two member of the Nuclear AMRC, has been awarded a new £20 million contract for work at Hinkley Point C.

The six-year contract, beginning in June 2017, will see Nuvia design, procure, manufacture, test, install and commission the nuclear sampling system (NSS) for Hinkley Point C, the UK's first nuclear power station for a generation.

The NSS is located within the nuclear island and determines the physicalchemical properties of liquid samples to ensure compliance with water quality specifications in the primary nuclear circuits and steam generators. "We are delighted to have been awarded this significant contract by EDF Energy which is an endorsement of our capability to develop and deliver solutions which address our clients' most complex challenges," said Keith Collett, Nuvia chief executive officer.

EDF Energy is now well under way on construction at Hinkley Point C in Somerset, with some 1,600 workers from 32 companies working on site preparation and civil works. Construction for the first EPR reactor building will start in 2019.

The NSS contract is Nuvia's third work package for Hinkley Point C. The company is working in partnership with Rolls-Royce to provide the primary circuit boron recycling and secondary effluent treatment systems under similar engineer, procure, construct (EPC) contracts.

www.nuvia.co.uk

Model glovebox stimulates nuclear careers

A demonstration glovebox made by Hosokawa Micron is giving students a hands-on experience of nuclear industry work.

The glovebox was commissioned by the National Nuclear Laboratory (NNL) to support public understanding and recruitment for the nuclear industry. It has been used at events including NNL's science and technology conference in Manchester, and a showcase at the Department of Business, Energy & Industrial Strategy in Whitehall.

"We were very pleased with both the excellent service we received from

Hands-on education: Hosokawa's demonstration glovebox.

Hosokawa and with the glovebox itself," said Adrian Bull, NNL's director of external relations. "On each occasion it has proved an excellent way to discuss the work we do and to engage people of all ages in conversation and practical experiments."

The acrylic glovebox replicates a full-size working glovebox, as used in the nuclear industry for tasks such as material analysis, sampling, operational engineering and waste management. It is designed to allow students to experience the specialist skills required to complete tasks in a protective environment with limited access.



Runcorn-based Hosokawa Micron Ltd provides a wide range of solutions for the processing and containment of materials for a variety of industries. The company was granted Fit For Nuclear in April 2016.

hosokawa.co.uk

Sellafield extends waste container work with Metalcraft

Stainless Metalcraft has secured an additional £11 million order to produce waste containers for Sellafield Ltd.

The new three-year contract extends a £47 million order, won in 2015, to produce 3m³ stainless steel containers for intermediate-level waste (ILW) from Sellafield's pile fuel cladding silos.

"This is another significant step forward for Metalcraft in this market," said managing director Austen Adams. "Over the last two years, the company has demonstrated its capability to produce these demanding ILW containers. The Metalcraft team, working closely with Sellafield, has established a great platform for the provision of these containers for years to come. It is pleasing to see this being recognised with the award of additional production volume."



Expanding production: Metalcraft opened its dedicated waste container manufacturing facility in November 2016.

In November 2016, Metalcraft opened a new 1,600m² production facility at its base in Chatteris, Cambridgeshire, to fulfil the Sellafield contract. The facility features a robotic welder offering both plasma and MIG welding; two new machine tool cells; test and assembly cells incorporating vacuum, pressure and dimensional inspection facilities; and a specialist cavity mixing and filling cell. Over the past four years, Metalcraft has received intensive supplier development support from the Nuclear AMRC through the Civil Nuclear Sharing in Growth (CNSIG) programme. CNSIG is supported by the Regional Growth Fund, and finishes at the end of 2017.

www.metalcraft.co.uk

Springfields visit fuels Westinghouse relationship

Nuclear AMRC directors visited the Springfields site of tier one member Westinghouse in June, to deepen their understanding of the company's current UK manufacturing capabilities and future new build ambitions.

Springfields is Westinghouse's UK nuclear fuel manufacturing facility, home to the Oxide Fuels Complex (OFC) which produces the fuel for EDF Energy's current UK nuclear fleet. OFC would manufacture the light water reactor fuel for Westinghouse's AP1000 reactors and its proposed small modular reactor (SMR) in the UK.

The Nuclear AMRC delegation was led by managing director Andrew Storer, on his first visit to Springfields, with programme director Colin Walters and business development director Jay Shaw.

"It was fantastic to welcome Andrew to site, as Westinghouse has worked closely with Nuclear AMRC on our UK new build ambitions over the last few years, and more recently with the Fit For Modules programme," said Mick Gornall, vice president and managing director for Westinghouse UK.

The directors discussed the importance of modular reactor designs for maximising UK economic growth from nuclear new



Close collaboration: Brian Nixon, head of oxide operations; Andrew Storer; Lindsay Roche, head of stakeholder relations; Colin Walters; and Jay Shaw.

build, and ongoing collaboration to build UK supply chain capacity and capability for Westinghouse's new build plans.

The Nuclear AMRC has recently undertaken a number of studies on behalf of Westinghouse, including on the manufacturability of its SMR reactor pressure vessel, and potential design efficiencies to further reduce SMR lead times.

www.westinghousenuclear.com/ springfields

Nuclear suppliers gather for Birchwood showcase

Around 325 nuclear professionals met at Birchwood Park, the heart of North West England's nuclear cluster, in July to showcase engineering and technology solutions for the industry.

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

Outgoing Nuclear AMRC chief executive Mike Tynan give the opening address, in one of his final appearances before retirement. The centre's Mantra travelling showcase was also on site to give a handson taste of the cutting edge of advanced manufacturing, with many of the visiting nuclear professionals testing their skills on the virtual welding simulator.

The event also featured technology demonstrations, including James Fisher Nuclear flying its unmanned aerial vehicles (UAVs) for remote inspection and surveying of nuclear sites.

The event was organised by Nu-Tech Exhibitions & Events, with support from the Nuclear AMRC, Nuclear Institute, North-West Nuclear Forum and Amec Foster Wheeler.









F4N connect

F4N Connect is a new online directory for Fit For Nuclear companies, launching in the autumn. F4N companies will be invited to submit their details for a free listing, including their manufacturing capabilities, products and services, testimonials and accreditations.

Nuclear buyers will then be able to search for qualified suppliers for their specific needs.

For more information, contact F4N administrator Rene Dorset: **rene.dorset@namrc.co.uk**



Forum for the young generation

Young nuclear professionals from across Europe visited the Nuclear AMRC as part of the European Nuclear Young Generation Forum in Manchester.

Run by the Nuclear Institute's Young Generation Network and supported by the Nuclear AMRC, ENYGF2017 aimed to showcase the UK's nuclear expertise to the world and facilitate knowledge transfer between countries and individuals.

The week-long event was the UK's largest ever youth nuclear event, with more than 550 young professionals and students from 32 countries – easily topping the numbers from the previous event in Paris in 2015.

The forum included expert speakers,

interactive workshops, technical presentations, discussion panels and networking opportunities. Nuclear AMRC business development director Jay Shaw took part in a panel discussion on innovation infrastructure and R&D challenges for the industry, while senior research engineer Miguel Garcia presented research on in-process inspection for large high-value components.

Research engineer Matt Smart presented a poster on the Nuclear AMRC's latest work

in near-cryogenic machining for nuclear applications, including a look at the new supercritical carbon dioxide coolant system for deep-hole drilling of heat exchanger tube plates and other critical components.

The forum also offered delegates a series of visits to key nuclear sites across the UK, including the Nuclear AMRC.

www.enygf.org



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.

namrc.co.uk/news/events

Diary

4th World Nuclear New Build Congress

11–13 September, London

Industry conference focusing on national incentives and supply chain development to stimulate nuclear new build.

www.szwgroup.com/nuclear-industrycongress-uk-2017

Triple Bar Nuclear Manufacturing

12–13 September, Oxfordshire

An essential introduction to nuclear industry expectations for manufacturers, from the National Skills Academy for Nuclear – ideal training for new entrants or employees with little nuclear experience.

www.nsan.co.uk/products-services/triplebar-nuclear-manufacturing

Advanced Engineering 1–2 November, Birmingham NEC

The UK's largest annual gathering of advanced engineering professionals. The Nuclear AMRC will be exhibiting with the High Value Manufacturing Catapult, and presenting case studies from the Fit For Nuclear programme.

www.easyfairs.com/advancedengineering-2017

NDA supply chain 2 November, Manchester

The Nuclear Decommissioning Authority's annual event highlights opportunities along the supply chain, and will include presentations from the NDA, site licence

companies and key government speakers.

decommsupplyevent.co.uk

Work with us

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

We help manufacturers through **supplier development** and **innovation**.

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

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

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

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

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



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