



Summary Report of Nuclear Asset Management Research Workshop

University of Strathclyde (20th and 21st March 2019)

June 2019



OFFICIAL

Nuclear Asset Management Research Workshop

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Nuclear Asset Management Research Workshop

1.0 Executive Summary

This report provides a summary of the Nuclear Asset Management Research Workshop at the University of Strathclyde on 20th and 21st March 2019. The NDA, the Environment Agency (EA) and the University of Strathclyde organised the event under the auspices of the NDA Asset Management Working Group. The event brought together delegates from across industry, regulators, academia, research institutes, supply chain and funding bodies.

The purpose was to identify opportunities to work collaboratively on asset management research. The workshop facilitated an understanding of the status of nuclear asset management research, challenges and cross-sector approaches. The workshop supports exchange of knowledge to further organisational objectives and regulatory outcomes.

The event has spawned considerable interest in working together within and outside the nuclear sector.

The following are a summary of the key points:

- The regulators (EA and ONR) encouraged licenced companies to use the tools identified in and become accredited to ISO55001; Effective lifecycle management of assets supports commitments in the UK Industrial Strategy and Nuclear Sector Deal to reduce the costs of decommissioning and construction;
- Recognition of common challenges that would benefit from collaboration across industry with support from supply chain and academia;
- Research is a broad topic covering technology and techniques (people, decision-making, skills, standards, experimentation, pilots etc,)
- There's a lot of good work going on out there, including outside of the nuclear industry, and there are opportunities to collaborate in a more cohesive manner that need to be exploited;
- Nuclear and other industry, regulators and academia are looking to the NDA (with support of licenced companies) to take the lead
- Opportunity to work with UKRI, EPSRC and other bodies to fund partnership approaches to developing low to mid Technical Readiness Level (TRL) technologies;
- Opportunity to work with industry and academia to fund development of Technical Readiness of solutions for industry and commercial exploitation;
- Appetites to collaborate through a structured approach taking advantage of existing forums to collate analyse, propose and govern integrated programme of work & research;
- We need a compile into a coherent picture, the research landscape for asset management making use of existing information offered at the event such as NIRAB and Strathclyde's research programme;
- A common means of sharing and codifying? best practice was suggested with OGTC, NDA HUB as options;
- Several ad hoc one to one follow up arrangements were made;

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- Proposal to have common dictionary, objectives and indicators to enable more effective collaboration;
- A need for more case studies to help strengthen cases for change and to provide 'lead and learn' opportunities;
- The Rail and Oil & Gas sectors were able to demonstrate mature arrangements and high public value from years of investment in lifecycle asset management research
- The value of the event has been affirmed by the following feedback:

"Making contacts with, and learning from, others that are on the same journey."

"I found the workshop interactive and useful in learning how colleagues in the different industries are tackling shared challenge areas."

"Highlighting the need for effective communication of the value good asset management "provides."

"Reinforcing the need for the whole of the enterprise to be aware of what good asset management is."

"Karl's presentation a breath of fresh air and it aligns with a lot of my thoughts of where we could move actively forward to optimise. 'One NDA' seems a very logical fit given recent and prospective changes."

"I have to say that I found the Working Group an outstanding and extremely worthwhile event, to the point that I'm a touch overwhelmed by the amount of industry-wide developments, learning and experience to tap into."

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2.0 Introduction

Asset management is focussed on the whole life cycle management of assets. Along with the NDA, the nuclear regulators consider lifecycle asset management to be crucial to ensuring the right investment decisions are made to manage risks (both threats and opportunities) to people and the environment, ensuring the best use of resources. This has been of particular interest since the release of ISO55001 setting out expected standards for asset management. Accreditation to this standard is encouraged by the Regulators.

This 2-day Asset Management workshop theme was focussed on Research; what is happening, where are the gaps, how can we collaborate to fix them? It took place at Strathclyde University, the home of the [Advanced Nuclear Research Centre](#).

Around 60 delegates attended representing 26 organisations, and whilst the majority were affiliated to the nuclear sector, there was significant involvement and input from non-nuclear companies, including speakers from Rail, Defence, Environment, Academia, Oil & Gas, Engineering and Construction consultancy industries.

The NDA, the Environment Agency (EA) and the University of Strathclyde organised the event under the auspices of the NDA Asset Management Working Group. The purpose was to identify opportunities to work collaboratively on asset management research. The workshop facilitated an understanding of the status of nuclear asset management research, challenges and cross-sector approaches. The workshop supports exchange of knowledge to further organisational objectives and regulatory outcomes.

The event focussed on:

- Understanding the current asset management landscape,
- The role of research and innovation in understanding, managing and improving asset performance,
- Identifying opportunities to work collaboratively on understanding in a more structured and detailed way the current status and needs, implementing and sharing the outcome of research,
- Establishing a commitment and plan to share and implement research.

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3.0 Approach

The event was conceived and organised by a working group comprising of representatives from the Nuclear Decommissioning Authority, Environment Agency and the Advanced Nuclear Research Centre (University of Strathclyde).

The overarching workshop was designed to bring about and continue lifecycle asset management by licenced companies. For example, the Environment Agency's nuclear industry inspection report¹, sought to determine areas of research (objective) needed, to ensure:

- a. reliable environmental performance of assets
- b. information needed was available and managed
- c. risks were established and understood
- d. collaboration on future asset management needs was commenced and was seen as key to delivering these objectives

Each objective was broken down into three sequential themes of:

1. What activity is taking place that currently supports the objective?
2. What are the gaps?
3. What needs to happen?

The event was publicised through an email contact list, the NDA HUB and an initial call for papers was sent to universities and licenced companies to help drive the agenda. The organisers subsequently convened a planning meeting in January 2019 at which all abstracts or offers were reviewed a final agenda was conceived and the workshops developed. Additional invitations to present were sent to network rail, the Oil and Gas Technology Centre (OGTC), EPRSC and BEIS. Members of the nuclear industry licenced companies, universities and research organisations were invited to attend the workshop.

Following an introduction and welcome address from the University of Strathclyde, the agenda for day one was designed to deliver an initial plenary context setting from the NDA, EA, ONR and non-nuclear industry subject matter experts.

Presentations based on the submitted papers were talked to with questions following. These are available on the NDA hub. The workshop session 1 followed, with individual table-based discussions being facilitated by the organisers to capture headline strategic thoughts on the question of The Strategic Map:

- What do we currently have that achieves our objectives?
- What works are in progress?

A tour of the ANRC University facilities also took place to close day 1.

Day two began with a series of presentations demonstrating examples of asset management related research and industry activities that are currently taking place followed by Workshop session 2. The

¹ EA/NRW, 2018. Theme Inspection Report. Status of Asset Management at Nuclear Permitted Sites in England and Wales. Summary report by the Environment Agency and Natural Resources Wales October 2018. Available on request from the Environment Agency

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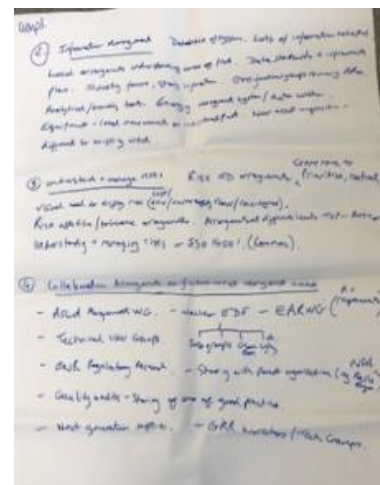
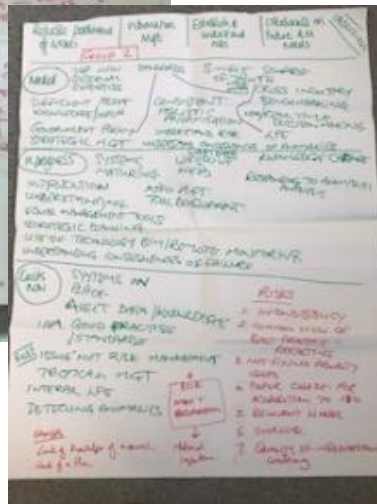
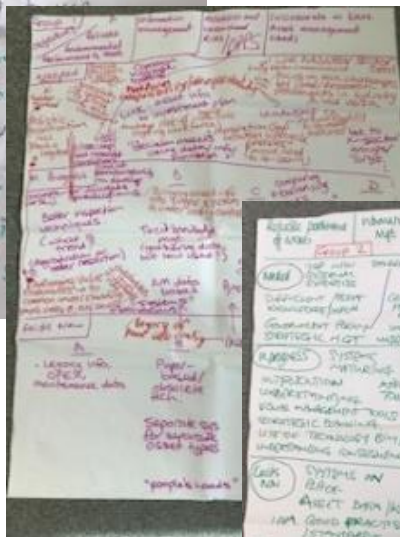
second workshop facilitated discussions which were designed to identify the perceived gaps by posing the question 'What areas require further research':

- What are the big risk areas?
- How do we prioritise the big risk / hazard reduction over quick wins?

A last series of four presentations were then given before the final Workshop that sought to address the issue of 'Delivering the research':

- How do we deliver the objectives including the different companies, our research partners, regulators and central government?

All the workshop discussion notes were captured on flip charts and fed back to the delegates. Following the event, a concatenation of the notes and emerging actions related to the objectives were documented as can be seen in Appendix 1.



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4.0 Presentation List

1	NDA Introduction to the workshop Speaker: Martin Grey, NDA
2	Relevant good practice for asset management Speaker: Douglas Styles, ONR
3	Improving asset management Speaker: Sarah Hawes, Environment Agency
4	Cross sector collaboration Speaker: Karl Sanderson, NDA
5	The journey to ISO55000: The experience of the Environment Agency to achieve ISO accreditation Speaker: Jim Barlow, Environment Agency
6	Development and certification of an asset management strategy for the Thames estuary flood defences Speaker: David Pocock, Jacobs
7	Asset management within the oil and gas industry Speaker: Pamela Lomoro, Oil and Gas Technology Centre (OGTC)
8	Network Rail's progress, learning and intended next steps in implementing improved asset management Speaker: Tim Kersley, Network Rail
9	Future asset management for nuclear fusion Speaker: Rob Buckingham & Emil Jonasson, UKAEA-RACE
10	The asset management R&D landscape at Sellafield Speaker: Lee Carr, Sellafield Limited
11	The Advanced Nuclear Research Centre: Industrial informatics for supporting through-life nuclear asset management Speaker: Dr Graeme West, University of Strathclyde
12	Unlocking our digital knowledge in support of nuclear asset management Speaker: Manon Higgs-Bos, National Nuclear Laboratory
13	Going digital to optimise compliance and reduce operational risk Speaker: Mark Eggleton, BakerHicks
14	AI and computer vision applications for structural safety inspection in the nuclear industry Speaker: Badri Hiriyur, Thornton Tomasetti
15	Alpha-contaminated gloveboxes decommissioning Speaker: Dr. Carmelo Mineo, University of Strathclyde
16	Automated monitoring installation and analysis Speaker: Dr. Marcus Perry, University of Strathclyde

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17	Overview of Research funding model – discussion only Speaker: Heather Macklyne UKRI EPSRC
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5.0 Next Steps / Actions

Following the workshop and concatenation of the workshop output, the following high level actions were agreed. The details of the particular

Item	Action	Owner(s)	Comments
1	Agree and document actions	NDA	Capture proceedings of event, analyse key points and action plans, EA end April 2019 (complete).
2	Publish event report	NDA	NDA, EA, UoS compile and publish event record by 14 th May 2019,
3	Create and co-ordinate dynamic action plan	NDA	NDA co-create with organisers a live action plan. Develop and enact action plan through engagement with relevant parties
4	Identify thematic organisational actions	NDA and delegated partners	Further actions to follow with participating organisations on key subject matters.
5	Develop collaborative funding application	NDA	A key component was the option to establish collaborative pilots within the low and high TRL domains as a proof of concept. There will be a need to consider cross sector and international partners (at the outset)

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Appendix 1: Concatenation of workshop Notes

no Task	objectives	objectives	objectives	objectives
	reliable environmental performance of assets	Information Management	Establish and understand risks	collaborate on future asset management needs
1 Map out funding framework				•
2 Asset management x sector group				•
3 List of information that can be shared? Guidance; AMWG; NEDF; Inst AM			•	
4 Publicise NDA AM strategy/update?			•	
5 NDA enforcement considerations				•
6 Sharing what companies are doing - Hub?				•
7 Decide Chair/Secretariat across all AM groups				
8 Benchmarking of companies against ISO 55000 standard requirements	•			
9 Problem/solution gap analysis - now and future				•
10 Better use of innovate networks - Hub?				•
11 Framework/terms of reference for forums - disseminate information and outputs actioned			•	
12 Centralisd repository of knowledge - x sector				•
13 Utilise WANO guidance - international benchmark			•	
14 Funded x industry academia forum - control of instrumentation in nuculear industry (e.g)		•		
15 Sellafeld quality of information model - can be used across all sites?		•		
16 Collaboration on training material for all persons who play role/buy-in				•
17 Understand cost benefit of asset management - reactive costs			•	
18 Communicate successes	•			
19 Leadership buy-in; sell the benefits - long term	•			
20 Technology to extract and share data in a usable form over long time spans		•		
21 Graduate/research placements into industry and vv				•
22 Use of VR for knowledge and retention		•		
23 Funding models are clear			•	
24 1 group coordinating industry research ?			•	
25 Guidance of available funding and funding processes - include timescales; collaboration between nuclear companies and providers			•	
26 Review/produce collaborative research group				•
27 Bring asset information into single system under configuration control		•		
28 Establish common information management into asset management databases		•		
29 Platforms for delivery of past information for decision making			•	•
30 Develop/carry out cultural re-alignment training	•			

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Appendix 2: Organisational Participation

- AWE
- BakerHicks
- BEIS
- Dounreay
- Environment Agency
- ESPRC UKRI
- FIS360
- Horizon Nuclear Power
- Inuserve
- Jacobs
- LLWR
- Magnox
- Mott Macdonald
- NAMRC
- National Nuclear Laboratories
- Network Rail
- NNB Gen Co
- Nuclear Decommissioning Authority
- Office for Nuclear regulation
- Rolls Royce
- Sellafield
- University of Strathclyde
- Thornton Tomasetti
- UKAEA
- URENCO
- WYG
- IHA Markit

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Appendix 3. Presentation detail

Full slide packs delivered at the event can be found here: <https://strathcloud.sharefile.eu/share/view/sbf09b1024834c848/foa7d55d-ae6f-44d1-b008-0a3bc6386d1f>

#	Presentation	Presentation Title	Summary
2	Douglas Styles ONR	Relevant good practice for asset management	ONR is responsible for the regulation of safety and security at nuclear sites across the UK. This includes sites at all lifecycle stages, from concept design and new build, through to operations, decommissioning and final site clearance. It carries out inspections across the UK's nuclear licensed sites, ensuring that licensees are complying with licence conditions. It takes enforcement action when licensees are found to be failing to meet the safety and security standards required by law. ONR produces Safety Assessment Principles (SAPs) which contain principles and guidance through Technical Assessment Guides (TAGs) to ONR inspectors on the interpretation and application of the SAPs. Asset management has been identified by ONR as a key strategic factor to the safe and secure management of the UK's new and existing nuclear infrastructure. ONR guidance takes account of relevant good practice, including: IAEA guidance, ISO 55000 series. ONR guidance has been broken down into 10 key Asset Management points (Scope, Policy, Planning, Implementation and Operation, Assurance and Resourcing, Improved Techniques for Condition Assessment, Better models for prediction of failure and mechanisms, Industry code of practice to provide a consistent approach to asset management, Risks/Opportunities whilst ensuring reliable performance
3	Sarah Hawes Environment Agency (EA)	Improving asset management	The EA explained how the requirements of regulations require effective management of assets on nuclear sites and presented the high-level findings from a recent cross industry themed inspection. The themed inspection identified that good progress has been made to establish

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#	Presentation	Presentation Title	Summary
			capability across the UK nuclear sector, with some areas of good practice, but there is a lot more to do to deliver the benefits of a proactive whole lifecycle approach. 5 principle areas for improvement are identified as common to a number of sites: adoption of ISO 55001, regular review and continuous improvement, review of risk appetite, asset information strategies and integration of asset management arrangements. It also made recommendations for industry improvements. The EA described their interest in and priorities in asset related research (working with the Scottish Environment Protection Agency and Natural Resources Wales): 1. Age related degradation of systems, structures and components, 2. Benchmarking and code of practice, 3. Prioritisation of asset management activities. It was noted that EA and ONR are working together in their regulation of asset management at nuclear sites. The EA also recommended in their recent asset management report (and this was repeated in the closing remarks of the workshop) that licenced companies follow and become accredited to ISO55000. (Noting EDF nuclear sites are accredited and all other nuclear site permit holders are actively reviewing the case for accreditation to the standard).
4	Karl Sanderson NDA	Cross sector collaboration	Karl Sanderson described NDA's interest in industry wide collaboration to add value to both the NDA and the partnership established based on the recognition that we have more in common than uniqueness. That includes decommissioning, which is a cross sector challenge for nuclear, oil & gas, defence, space, process, renewables, waste, marine. There are a series of ongoing conversations established on 15 themes of common interest to nuclear and oil & gas which includes late life asset management with the following shared interest areas: Efficient overlapping of late operations and onset of decommissioning; Minimizing duration of warm stacking; Managing trade-offs between OPEX and ABEX; Cultural change and leadership during transition from (operations to decommissioning).
5	Jim Barlow Environment Agency	The journey to ISO55000: The	Jim Barlow presented the journey of the Environment Agency Flood and Coastal Risk Management (FCRM) team from their initial PAS-55 assessment to ISO55001 accreditation and

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#	Presentation	Presentation Title	Summary
		experience of the Environment Agency to achieve ISO accreditation	<p>the value of managing their assets well in a risk based whole lifetime context. The following key points arose: 1. Value in utilising independent IAM accredited auditors and benchmarking, 2. Utilisation of an Infrastructure Projects Authority (now Major Projects Authority) review approach led by a senior OFWAT Director was fundamental to having credible findings for stakeholders to appreciate, 3. Transition to good practice is a change programme that takes a number of years to achieve, requiring active leadership and projectised approach to enable a shift in organisational culture and capability. The transition from PAS-55 to ISO55001 has taken 4 years, with ISO accreditation achieved in 2018 4. Embedding good practice capability across geographically spread organisation provides provided the consistency required to optimise, 5. Alignment of training and skills to ISO standard utilising E-learning was developed in 2018,tailored to individual needs, and was key to communicating the discipline of asset management to a large workforce, 6. Organisational credibility attained with stakeholders and government through accreditation and performance achieved, 7. Importance of linking organisational values to performance management requirements down through organisation, including line of sight from policy through strategy to individual objectives, 8. Key to good asset management is establish control of asset cost, risk and performance, 9. Importance of considering capital and revenue spend in integrated decision making, 10. Importance of reliable costs capture and other performance information to aid good decision making, 11. Planning incorporating a balance of risk and resources, 12. Plans and activities to mitigate risk does not mean the risk has gone away, there is always a degree of uncertainty, 13. £1Bn a year is spent in controlling the risk of flooding at the current level, 14. There is an up-front cost but has paid back in many tangible and intangible forms not least in influencing stakeholders especially when seeking funding, 15. The 2014 Somerset plains flooding provided a platform to drive through the improvements, 16. Managing liabilities, some of which are 100's of years old, is an ongoing challenge but requires the same asset management approach in seeking to resolve, 17. The journey continues, having gained accreditation, maintaining accreditation</p>

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#	Presentation	Presentation Title	Summary
			requires ongoing effort to demonstrate the organisation continues to improve and apply learning as losing accreditation is not palatable to EA and Stakeholders.
6	David Pocock Jacobs Ed Morris Team 2100	Development and certification of an asset management strategy for the Thames estuary flood defences.	David Pearse and Ed Morris described the accreditation journey and value of improving management of assets to prevent floods on the Thames estuary to EA supported by Jacobs. The approach had been hugely successful and resulted in the IAM team of the year award. Key points include: 1. Integrated client and supplier teams, 2. Integrating project delivery into business as usual to maintain overall control of risk, 3. Innovation and creativity through shared incentives and benefits, 4. Utilising Water Services Association of Australia assessment methodology to provide benchmarking that is based on WANO approach which allows organisations to "buddy up", 5. Integrating capital investment and maintenance decision making, 6. Aligning objectives based on a 100 years strategy that has enabled a flexible 10 year investment commitment allowing an adaptive approach to managing risk e.g. plan for 2 ^o C temperature rise enabling up to 4 ^o C adjustment. Importance of Monte Carlo whole life cost modelling to support scenario development and 50 year business case linked to 10 year funding, 7. Portfolio of assets comprising many that have evolved over many centuries in some instances, to those that are recently built.
7	Pamela Lomoro OGTC	Asset management within the oil and gas industry	Pamela Lomoro introduced the Technology Vision for Oil and Gas aligned to the following strands: 1. Fix today, 2. Maximise Recovery 3. Transform tomorrow. With 90% of assets reaching end of life in the next 10 years there is a heavy emphasis on how to maximise recovery at this stage of the lifecycle. Research is a key contributor towards finding solutions: 1. Commercial focus on solutions with supply chain connected to operators, 2. Decommissioning research driving Technical Readiness Level, 3. Bringing universities closer to industry. Having worked with NDA there are a range of challenge synergies: decision making, legislation, technologies (robotics, AI, digital twinning, re-use, design with decommissioning in mind, surveying and planning, late life asset management, post decommissioning monitoring, future design. Mechanisms include: better collaboration, holistic data utilisation, engagement

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#	Presentation	Presentation Title	Summary
			with catapult initiatives, developing and adding to research landscape
8	Tim Kersley Network Rail	Network Rail's progress, learning and intended next steps in implementing improved asset management	Tim Kersley introduced Network Rail's asset management challenge to the delegates. He provided a frank view of the journey Network Rail has been on, the challenges and a view of what challenges remain using the IAM's Big Picture to identify with the issues and their 'Vision for Excellence'. All the delegates identified with the Network Rail experience and journey. Key points from the presentation and discussion: 1. Top down benefits led approach, 2. Importance of people to success, 3. Quality and timeliness of information to enable effective decision making and loss (£) avoidance, 4. Establishing and using a common currency of risk to allow consistent prioritisation, 5. Importance of understanding impact of reliability on performance ("service affecting reliability"), 6. Benchmarking performance within and outside the sector, metrics aligned to ISO 55001 excellence benchmark, 7. Potential for replication of research requiring mechanism to resolve, 8. Developing digital capability including twinning, noting the concept does not yet have an agreed definition. The vision for the next 15 years includes working cross sector. Critical to progress is improving the management of information using a benefits led approach and effective identification and utilisation of research. IAM's Big Picture was used to show the remaining journey and the key areas for development to enable a holistic approach to be implemented across Network Rail driven by a common understanding of value and purpose in all that's is done.
9	Rob Buckingham Emil Jonasson, UKAEA-RACE	Future asset management for nuclear fusion	The presentation described more than 20 years of experience of remote operations at the JET fusion reactor at Culham in Oxfordshire. This is a unique system which has been used to maintain and upgrade the internals of the JET reactor. The team has 30,000 hours of in-vessel operations including the remote exchange of 4,000 in-vessel components and 60,000 hours of training and process development on a full-scale mock-up. This is an end-to-end process which includes process tools, delivery robots, control systems and user interfaces, virtual and augmented reality, operating management systems, condition monitoring systems, decontamination methods and logistics management, all within a nuclear safety case to deliver critical path shutdown programs on a high value asset. The value in the technology has allowed

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#	Presentation	Presentation Title	Summary
			them to understand fully the performance and maintenance of the asset.
10	Lee Carr Sellafield Limited	The asset management R&D landscape at Sellafield	Lee Carr showed a video explaining Sellafield's mission. He explained the complexity of the site and reliance on R&D and technology to securing effective lifecycle management of the assets. Like Network Rail, work is ongoing to align the approach to value requirements set by NDA to define the purpose for assets in delivering the 4 value streams: 1. Retrievals, 2. Remediation, 3. Spent Fuel Management, 4. Special Nuclear Materials. A number of R&D themes have been developed that include rules, tools, culture, risk and capability. Visualising the Sellafield asset base is a key development area to enable effective performance management and stakeholder communication. Asset management is featuring strongly in the Game Changers approach being facilitated by FIS360 with an event being held on 23rd May. The Game Changers Innovation Programme provides the opportunity to bring ideas and technologies to the UK's largest decommissioning cluster. https://www.gamechangers.technology/process/
11	Dr Graeme West University of Strathclyde	Industrial informatics for supporting through-life nuclear asset management	Graeme West introduced the Advanced Nuclear Research Centre. The Advanced Nuclear Research Centre focuses on infrastructure and management of nuclear installations. There are 4 current priority areas supporting Sellafield, EDF and Supply Chain. ANRC bridges the gap from low technical readiness to high technical readiness levels to enable industrial application and commercial development and delivery of benefit to industry. Industrial informatics is bringing together capabilities already utilised by Facebook and other global IT organisations to gather and analyse disparate data as an aid to decisions at all levels. Graeme offered the opportunity to be involved in a deep dive into the work being done
12	Manon Higgins-Bos NNL	Unlocking our digital knowledge in support of nuclear asset management	Manon Higgins-Bos introduced GOLDFIRE, an advanced knowledge discovery tool utilised by hundreds of industry wide Global 200 companies. It was adopted by NNL to enable rapid search of unstructured historic documentation in a range of modern languages allowing access to critical intelligence to be gathered, analysed and utilised. The capability a GOLDFIRE type tool provides can enable easy access to critical information that might otherwise be overlooked making better use of Engineer's time, help avoid costly information system development and

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#	Presentation	Presentation Title	Summary
			aid in delivery of nuclear sector deal commitments on construction and decommissioning. GOLDFIRE has been used to support BEIS and Oil and Gas Technology knowledge capture, collaboration and sharing. Globally the tool has enabled speed to market, improved market share, operational efficiency improvement, ageing workforce management improvement and better risk management. Utilisation of the search capability alongside integrated use of knowledge hub capability development in Oil and Gas sector and the NDA has huge potential to collaborate more effectively and improve performance and efficiency.
13	Mark Eggleton BakerHicks	Going digital to optimise compliance and reduce operational risk	<p>Mark Eggleton described some of the common information management challenges and organisation experiences that impact on operational risk. These are BIM 2 compliant projects not aligned to operational works packages, many sources of information in varying configurations make access difficult, legacy information management systems ineffective for modern management and costly, inability to make properly informed lifetime decisions based on reactive short terms approaches (Referenced Woolstenholme report "Never waste a good crisis"), records (particularly underground assets) causing delay and added cost impacting projects, planned work.</p> <p>All contribute towards poor business intelligence. Addition to the information challenges a key barrier to success is the lack of integration across businesses, for example, integration engineers not integrated into data collection and analysis systems. Better information management enables better asset management enabling better outcome delivery.</p>
14	Badri Hiriyur Thornton Tomasetti	Artificial Intelligence for Damage Detection and Structural Health Assessment in the Nuclear	<p>Badri Hiriyur described the development of the technology being used. They were motivated by the need to inspect efficiently and safely, data needing to be of good quality and repeatable, focused on the development of technology to allow remote inspection (UAV) and intelligent analysis (AI). The use of Artificial Neural Networks to map inputs from digital inspections to identification of asset condition was explained. Examples of how the AI technology (with input from experts) learns to identify and classify structural defects found were provided showing pictures of the outputs. The AI accuracy was described.</p>

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		Industry	The use of android mobile phones as detection devices was demonstrated through a video as a proof of concept. The ability to identify true damage from other issues is key with built in logic to differentiate alongside an ability to quantify the damage and track its progression over time.
15	Dr. Carmelo Mineo University of Strathclyde	Alpha-contaminated gloveboxes decommissioning	Carmelo Mineo showed how collaboration across research bodies led by NNL on behalf of industry is developing the ability to robotically dismantle alpha contaminated glove boxes. The capability being developed is utilising laser cutting supported by "Smart Grasping". Demonstration is being provided through simulation software. The ability to identify materials through laser bar coding is also being developed. Digital visualisation is another key development. The project has demonstrated feasibility of autonomous robotic control systems with funding being sought to increase the technical readiness level through amalgamation of the research into one functional robotic control system allowing an autonomous sort and segregation system to be tested.
16	Dr. Marcus Perry University of Strathclyde	Automated monitoring installation and analysis	Marcus Perry from the University of Strathclyde described the common issue of concrete degradation across industries, showing that there is a number of common mechanisms which results in the erosion of the margin between design strength and loading , Common issues were design errors, leaks and leaching, shrinkage, creep, chemical attack, chlorides, biofouling, sulphates and freeze-thaw. There are two options, monitor or repair and protect. The projects is investigating the possibility of combining the two by installing monitoring capability when repairing so called "smart repairs". Examples showing the use of the proven technique of Geopolymers for repair were shown. The Geopolymer has the same properties as cement but allows electrical conduction, is resistant to chemical attack and durable under freeze-thaw conditions. Options are being investigated to move from manual to automated repair techniques to improve quality and reduce cost and risk. Work is running in parallel to make sense of the outputs from monitoring to provide real time indications of structural integrity through analysis and modelling, for example, on wind turbines on behalf of EDF, SSE and Scottish Power. The benefits to industry of these new techniques are risk and cost reduction,

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#	Presentation	Presentation Title	Summary
			improved reliability, repeatability and scalability and the ability to identify new products and methods
17	Heather Macklyne UKRI EPSRC	EPSRC Nuclear Portfolio Overview of Research funding model	Heather Macklyne explained how funding flowed from Treasury through BEIS, into the various research coordination organisations. Within the energy theme (funding sector) there are 12 research areas within which nuclear fission and fusion sit. The energy theme through the research councils is seeking to reduce Greenhouse Gasses and costs whilst enhancing security of supply. Nuclear Fission has 72 live grants spending £76M (25%) of EPSRC Energy Budget. The portfolio covers existing operational and decommissioning nuclear challenges, future technologies, research infrastructure requirements and international engagement. The two funding routes are managed activities which are large investment spanning the UK and supporting international programmes and community led.

