

The logo for the Nuclear Decommissioning Authority (NDA), consisting of the letters 'NDA' in a bold, white, sans-serif font.

Nuclear
Decommissioning
Authority

November 2015

A large, stylized graphic of the letters 'R&D' in white, set against a blue hexagonal background. The hexagon is part of a larger geometric pattern of overlapping hexagons in various shades of blue and grey that covers the right side of the page.

Research and
Development

Driving solutions, delivering progress



“The R&D work carried out at our sites is critical to solving some of the unique and complex decommissioning challenges that we face.”

Prof Melanie Brownridge, NDA Head of Technology

Shared R&D is more effective, more efficient – and reduces costs

The UK’s nuclear energy programme, dating from the post-war years, has left a mixed legacy to the country: numerous prototype reactors, fuel-manufacturing plants, research centres, reprocessing plants and 11 power stations. The Sellafield site in west Cumbria houses more than 200 nuclear facilities and 1,000 buildings, making it one of the world’s most complex environmental decommissioning challenges.

The UK’s diverse, hazardous legacy is being dealt with by the NDA and includes radioactive waste from commercial electricity generation as well as from the defence programme. Many of the facilities are one of a kind and may subsequently present unforeseen difficulties for the decommissioning mission.

One of the NDA’s responsibilities is to ensure that

the right level of Research & Development (R&D) is carried out to enable progress on delivering the full decommissioning programme.

Many ‘never-done-before’ projects are under way, which require substantial levels of R&D and innovative engineering approaches. The aim is to solve these problems more effectively, more efficiently and, where possible, for less cost to taxpayers.

R&D funds are directed at ensuring the fundamental technical areas relevant to the challenges are understood, encouraging the development of innovative ideas and enabling demonstration of new technologies, followed by successful on-site implementation.

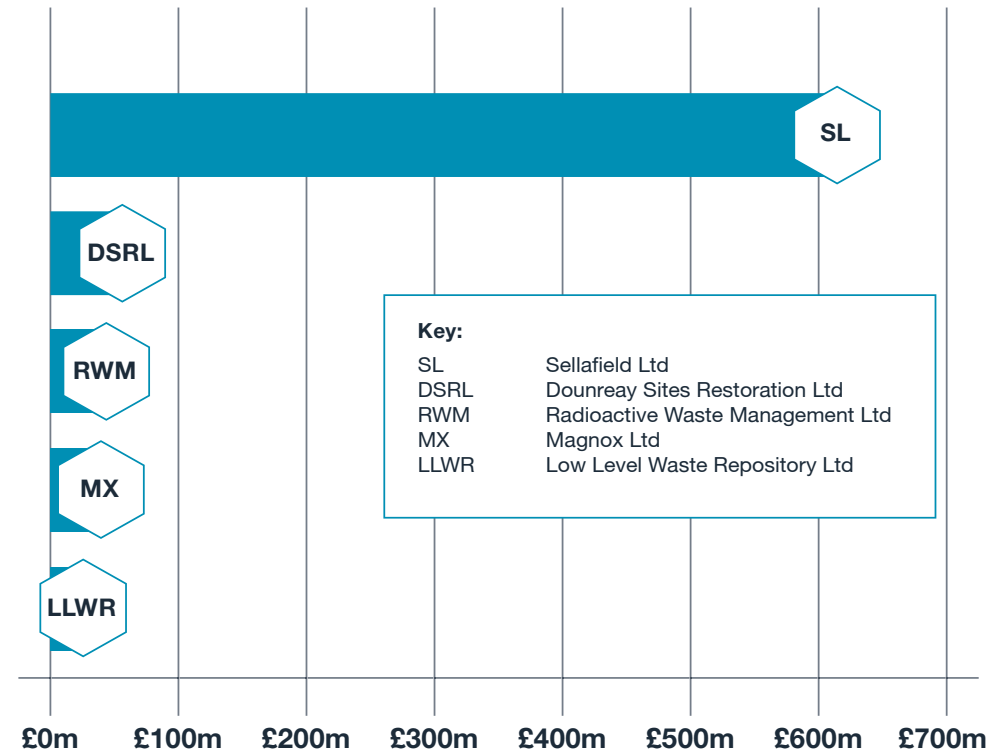
To maximise the benefits of R&D and avoid duplication, the NDA promotes the estate-wide sharing of good practice and the adoption of innovative ideas, where appropriate, across multiple sites. In addition, the NDA works with the wider nuclear sector and beyond, both in the UK and internationally, to secure best value for money from our R&D investments and learn from experiences elsewhere.

While the NDA funds a proportion of R&D directly, sites take the lead in identifying site-specific issues requiring investment and draw up detailed development plans. This brochure looks at the work carried out by the site operators (the Site Licence Companies or SLCs) and their suppliers.

Site-focused R&D spending totals more than **£85 million** a year across the whole estate

The majority of R&D work is targeted at Sellafield's technical challenges - more than £70 million in 2014/15

Predicted R&D spend over the lifetime of the whole estate



The NDA is responsible for:

- Taking a strategic, estate-wide view of all site-based projects
- Ensuring that sites' overall programmes are technically robust
- Identifying opportunities for sharing or applying technologies across multiple sites

SLCs follow a rigorous process to identify research needs and opportunities, estimate associated costs and measure progress. This provides the NDA with visibility across the estate and confidence that the plans can be achieved.

SLCs are required to produce a comprehensive analysis of R&D plans that:

- Link R&D needs to a site's overall lifetime plan
- Outline any links with other on-site work
- Estimate timeframes and costs
- Describe technical risks and possible opportunities
- Monitor progress and how projects are governed
- Use a consistent system for assessing the maturity of a technology, known as Technology Readiness Levels

This suite of documents is collectively called the Technical Baselines and underpinning R&D (TBuRD).

Currently, the bulk of the site-related R&D work is carried out at Sellafield and focuses on decommissioning the highest risk and hazard facilities. However, other sites still have their technical challenges and need specific solutions to support their decommissioning.

Typical SLC work

Examples of SLC-led R&D work include:

- More efficient methods of dealing with large quantities of contaminated spent fuel skips, using industrial milling and laser cutting
- Remotely operated equipment deployed in heavily contaminated areas, avoiding the risks to workforce
- Unmanned aerial vehicles carrying, for example, radiation-detecting cameras
- Novel means of cleaning contamination from inside pipework
- Pioneering nuclear use of 3D printing for metallic components
- Using highly penetrating cosmic rays to produce accurate 3D images through dense material such as stored waste
- Borehole drilling technique that avoids production of surface spoil from contaminated ground
- Collection of legacy pond water data using lightweight underwater probes, operated remotely
- Ensuring a fundamental understanding of legacy wastes such as sludges to ensure they can be dealt with appropriately

Through the investment programme, the NDA is:

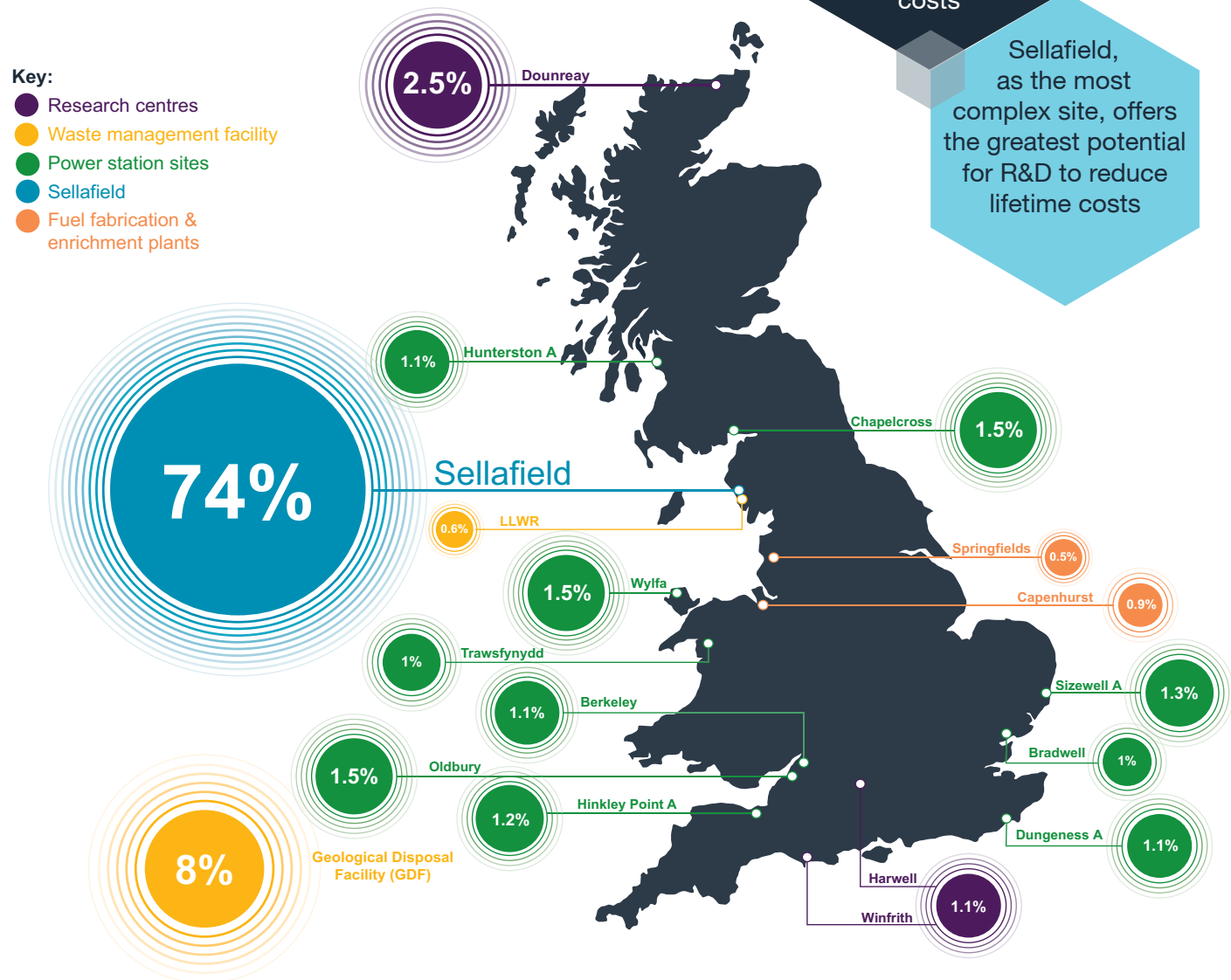
- A significant funder of nuclear R&D in the UK
- Supporting growth in the UK supply chain, particularly with smaller businesses
- Contributing to delivery of the government's Nuclear Industrial Strategy
- Building a skills pipeline of technical experts
- Bridging the gap between innovators and end-users

Lifetime Costs: up to 120+ years

The current estimate is that clean-up costs across the UK will be in excess of £115 billion spread over the next 120 years or so.

The map highlights where R&D can play a significant role in reducing lifetime decommissioning costs

Sellafield, as the most complex site, offers the greatest potential for R&D to reduce lifetime costs





Attendees at a recent NWDRF meeting focusing on innovation

Nuclear Waste and Decommissioning Research Forum (NWDRF)

The NWDRF's objectives are to:

- Promote understanding and collaboration between all relevant nuclear organisations on R&D related to the NDA mission
- Identify common R&D needs, gaps and opportunities, with a view to encouraging collaboration
- Support the delivery of R&D for SLCs and other operators

R&D Governance

To provide advice and support co-ordination of nuclear decommissioning R&D across the UK, the NDA established its Research Board, which is independently chaired. Membership comprises senior representatives from all sectors of the nuclear industry, including the government, regulators, SLCs, industry, research councils, overseas experts, Radioactive Waste Management Limited (RWM) and the NDA. The NDA also contributes to the wider UK picture through the government's Nuclear Innovation and Research Advisory Board (NIRAB).

The Research Board's work is supported by the Nuclear Waste and Decommissioning Research Forum (NWDRF), a cross-industry network of UK nuclear site operators which meets quarterly.

The group promotes understanding and collaboration on R&D related to site decommissioning, remediation and waste management. Its membership includes representatives from NDA, RWM,

SLCs and organisations with significant nuclear decommissioning liabilities, eg, EDF Energy and Ministry of Defence (MoD). Regulators and other relevant bodies attend as observers.

Such collaboration ensures innovations are delivered more efficiently, more cost-effectively and can be deployed more rapidly, while avoiding duplication.

The NWDRF has six technical working groups which focus on the following areas:

- Characterisation
- Waste packaging and storage
- Land quality
- Decommissioning
- University-based work
- Common approach to Technical Baselines and underpinning R&D (TBuRD)

Among the events organised by NWDRF to promote sharing are webcasts and industry days.

Webcasts to participants from both the UK and overseas enable a wide level of participation and innovation-focused discussion between researchers and technology end-users.

Topic-led industry days, meanwhile, provide opportunities for face-to-face networking on issues of common interest. A recent event, for example, focused on operators' experiences of both conventional and innovative cutting and decontamination technologies.

collaboration case study: SELLAFIELD

From drawing board to detection work



Riser uses its own internal navigation system to manoeuvre inside industrial spaces

Challenge: Accessing a high-dose environment and securing accurate information on contamination distribution

Solution: Remotely operated unmanned aerial vehicle combined with radiation mapping software

Technology: Remote Intelligence Survey Equipment for Radiation (Riser)

Benefits: Reduction in dose to operators from remote technology, effective characterisation of a historic facility to enable decommissioning to progress

Status: Deployed on site

SLC: Sellafield Ltd

Delivery partners: Blue Bear Systems Research Ltd, Createc, Sellafield Ltd

Website: www.bbsr.co.uk and www.createc.co.uk

A sophisticated radiation mapping system mounted on a drone is collecting vital information from deep inside the chimney of Sellafield's remaining Windscale Pile.

The 1957 fire left radioactive contamination levels too high for decommissioning work to start. Although the intervening years have reduced these levels, remotely operated equipment is still needed to establish how the chimney can be cleaned out and dismantled.

The lightweight Riser (Remote Intelligence Survey Equipment for Radiation) system combines two separate pieces of technology, drones and radiation mapping software, that have both received R&D funding through different routes.

In 2009, Createc's N-Visage™ radiation mapping software project received a £50,000 investment from the NDA, enabling continuing development during the critical early stages.

Three years later, the NDA was part of a joint investment by government organisations in a wide range of UK nuclear R&D projects. This led to the collaboration between Createc and aerial systems specialist Blue Bear, together with on-site trials at Sellafield - and Riser was the result.

N-Visage™'s tailor-made technology detects and maps radiation with pinpoint accuracy, producing a 3D high-definition picture of contamination, quickly and safely. Developed and exhaustively tested over a number of years, the compact, lightweight N-Visage™ system has already been used inside

one of the reactor buildings at Japan's Fukushima plant. The system is compact, lightweight and can be deployed through small openings, in tight spaces and in high-dose environments. Dose to operators is reduced as the technology is remotely deployed.

After many trials, Riser was deployed in the Windscale Pile where it has provided hugely valuable information about internal contamination that will enable decommissioning plans to be drawn up.

The drone, or unmanned aerial vehicle (UAV), is less than one metre in diameter and navigates using its 'collision avoidance' capability. Able to manoeuvre accurately inside complex industrial spaces, data is transmitted to the mapping system and is displayed, highlighting areas of contamination as well as radiation levels.



R&D approach

In 2012, a UK-wide government initiative was launched by Innovate UK, the NDA, Department of Energy and Climate Change (DECC) plus the Engineering and Physical Sciences Research Council (EPSRC). Worth £18 million in total, the investment was aimed at encouraging innovative ideas from supply chain companies, especially smaller businesses, across the nuclear sector and beyond to be developed collaboratively for potential industrial deployment.

The funds matched investment by private sector organisations. The money was shared among a wide range of projects at varying levels of development, covering all aspects of the nuclear sector.

The development of Riser, which built on the early NDA investment in N-Visage™, illustrates two of the routes that can encourage technological development:

- Support at the early concept stage – *from NDA's R&D portfolio*
- Support for potential collaboration with other relevant technologies – *from co-funded government initiatives including NDA's funding*
- Ongoing support to explore how a technology can be deployed at site level - *from SLCs as potential end-users*

Extensive trials preceded Riser's deployment inside Sellafield's Windscale Pile chimney

Mini-robot's underwater mission



The mini-robot can be used under water and, thanks to 3D printing, can be produced inexpensively

Challenge: Providing a cost-effective way to survey difficult-to-access underwater areas in legacy storage ponds

Solution: Combine 3D printing technology with the capability of mini remotely operated vehicles and on-board sensors

Technology: AVEXIS-Mini

Benefits: Reduced cost of equipment, easily tailored to specific scenarios, deployment under

water, minimising dose to operators, access to difficult areas

Status: Further development and on-site demonstration trials planned

SLC: Sellafield Ltd

Delivery partners: Sellafield Ltd, The University of Manchester and Forth Engineering Ltd

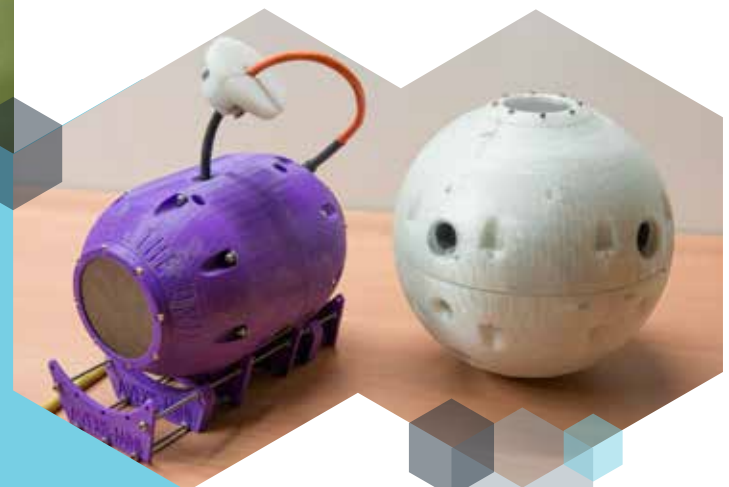
Website: www.manchester.ac.uk and www.forth.uk.com

Monitoring the radioactive contents of both modern and historic storage ponds presents an important but difficult decommissioning challenge.

A number of remotely operated vehicles (ROVs), each with different characteristics, are now under development for use at Sellafield. One example is the AVEXIS-Mini, an underwater robot designed for mapping and real-time monitoring of pond waste.

The AVEXIS-Mini addresses a variety of scenarios and can carry different on-board sensors. This mini-ROV, with on-board camera capabilities, can be deployed through existing holes of only 15cm in diameter, allowing access to challenging contaminated areas where there is limited information.

The flexibility of the design is facilitated by 3D printing which allows a quick, inexpensive way to produce the AVEXIS-Mini on demand.



case study: SELLAFIELD

Waste treatment using industrial robots



Sellafield's Box Encapsulation Plant (BEP) will receive and treat a mixture of solid lower level radioactive waste from a number of historic waste facilities around the site.

The waste must be remotely manipulated and processed to allow grouting into a product suitable for long-term storage and eventual transfer to a more permanent facility.

Sellafield has been leading a collaboration to evaluate robot technology and its potential for use in BEP. "Off-the-shelf" robots used in other industries have been successfully trialled, demonstrating the full range of waste handling operations required to ensure the waste can be manipulated and processed into a suitable solidified product. A comprehensive selection process identified equipment required to test the robotic technology's capabilities at the National Nuclear Laboratories (NNL) Workington facility. The chosen robots were robust, reliable, easy to use and readily available already.

The trials demonstrated a range of capabilities:

- Sorting of waste from skips
- Opening packages to break them down into component pieces
- Flexibility to receive and process waste from a range of legacy facilities
- Reducing the probability of producing packages that fail to meet specifications for disposal as the grout is able to flow around the waste to form a suitable product.

All of these capabilities mean that waste arriving in BEP can be consolidated and the packing into the waste containers maximised with the optimum flow of grout to form a suitable solid product. Successful deployment of these capabilities will significantly reduce the number of products produced thus lowering the decommissioning and waste storage costs.

Challenge: Remote waste handling operations

Solution: Evaluate robot technology and its potential for use in the Box Encapsulation Plant (BEP)

Technology: Off-the-shelf robots

Benefits: Waste consolidation, cost reduction

Status: Trials to demonstrate the capability of the robots

SLC: Sellafield Ltd

Delivery partners: Sellafield Ltd, NNL, Kuka Systems (UK) Ltd, NSG Environmental Ltd and TÜV SÜD Nuclear Technologies

Website: www.nnl.co.uk, www.kuka-systems.com, www.nsgltd.com and www.nuclear.co.uk



Photographs: The robots have been adapted from other industries to use in BEP, where they will be operated remotely

case study: **DOUNREAY**

Platform for remote handling



Conventional hydraulic and electrical equipment has been re-engineered to use in Dounreay's Shaft and Silo

Removing 1,500 tonnes of waste from Dounreay's 65-metre shaft is the world's deepest nuclear clean-up job and one of the site's most challenging tasks.

The shaft was originally sunk to allow a tunnel to be built for the discharge of low-active radioactive effluent. In 1958, the shaft was licensed to take radioactive waste and was routinely used over almost 20 years for the disposal of unconditioned Intermediate Level Waste (ILW). The waste must be retrieved so it can be safely packaged for long-term disposal.

With radiation levels too high for workers to operate in the shaft, remote handling is the only option for retrieving the material. A specialised platform has been developed, with telescopic mechanical arms attached to the underside which will reach down, grab the waste and bring it back to the platform.

The technology has been adapted from conventional hydraulic and electrical equipment, brought together and re-engineered to use in the shaft, with the additional requirement to operate remotely. The highly flexible system can tackle a range of activities

Challenge: Waste retrieval from deep, contaminated shaft

Solution: Re-configure range of mechanical equipment for highly specialised intervention

Technology: Shaft Intervention Platform (SIP)

Benefits: Flexible, cost-effective, can be adapted to specific scenarios, able to operate remotely in high-dose environment

Status: Further development and on-site demonstration trials planned

SLC: Dounreay Site Restoration Ltd

Delivery partner: Oxford Technologies

Website: www.oxfordtechnologies.co.uk

including the grab becoming stuck and the cutting up in the shaft of items too large or heavy to be retrieved in one piece.

Recent trials involved the use of a high-pressure water cannon that is able to wash out the sludge left behind in a short stub tunnel after the grab arms have retrieved larger items. Several different kinds of replica sludge were used to demonstrate the process would be successfully deployed.

case study: LOW LEVEL WASTE REPOSITORY

Performance of grout additives



Trials are being carried out to understand the performance of various superplasticisers

Challenge: To demonstrate optimal performance of alternative commercially available superplasticisers in terms of grout performance and retention of contaminants

Solution: Screening of commercially available superplasticisers using non-active simulants of key radionuclides and a leach-testing process designed to model the behaviour of typical contaminants

Technology: Bespoke leach testing methodology, standard modelling packages and routine analytical techniques

Benefits: Non-active experiments; Inexpensive laboratory protocols and materials; standard modelling techniques; and standard analytical chemistry approaches are used

Status: Further analysis of different superplasticisers is under way, with a bespoke leach testing system under consideration to obtain better data

SLC: Low Level Waste Repository Ltd

Delivery partners: Amec Foster-Wheeler and Scientific Analysis Laboratories (SAL) Ltd

Website: www.amecfw.com, www.salltd.co.uk

Solid Low Level Waste (LLW) waste arriving at the UK's Cumbrian repository is often encased in a cement-type grout to seal in any residual radioactivity and create a stable air-free mass that is suitable for disposal in a container.

This grout mixture contains standard cement but also incorporates a polymer-based superplasticiser that increases grout fluidity, enabling better penetration of any voids and creating a more stable material. Superplasticisers also reduce the amount of water remaining after the grout has been left to harden.

Although superplasticisers can render some radionuclides more mobile, carrying implications for compliance with environmental regulations, Low Level Waste Repository Ltd (LLWR) is confident the benefit, for waste with low levels of radioactivity, outweighs this detriment.

As the current superplasticiser is now discontinued, LLWR is using a replacement product, with regulator agreement. However, all suitable alternative commercially available products need to be assessed for optimal performance in view of the potential for radionuclide mobility. Initial results suggest the replacement superplasticiser is suitable and meets LLWR environmental requirements. However, it is not necessarily the clear optimum choice as other products have varying impacts on the mobility of radionuclide simulants, and further analysis is under way to make sure the optimum solution can be found.

Benchtop trials are playing an important role in continually improving understanding of key technical processes and ensuring the best options are always used.

case study: MAGNOX

X-Ray sorting for Fuel Element Debris

X-ray sorting techniques are being trialled at two Magnox sites to remove higher activity items from the mixed metallic debris, known as Fuel Element Debris or FED, that is shaved off spent fuel elements.

The technology is based on the airport X-ray scanners that check luggage and are also routinely used in the waste metal industry. Members of a project team at Hinkley Point A and Oldbury have successfully undertaken initial trials with an industrial X-ray sorting machine, using a FED simulant. The two sites have more than 1,100m³ of FED, however more than 95% of the activity is contained in less than 5% of the total volume: nimonic springs which are categorised as Intermediate Level Waste.

Removal of the ILW springs, together with broken spring fragments, via the X-ray sorting process enables a significant volume of the bulk of the waste, which is lightly contaminated, to be treated more cost-effectively as Low Level Waste (LLW). The segregated ILW will be treated and packaged for storage.

The trials demonstrated that the machine could distinguish accurately between different kinds of FED, operate at sufficient speed, could be easily adjusted and provide performance data.

The team propose to use X-ray scanning in conjunction with the already proven magnet-based technology of Eddy Current Separation to provide a fully automated solution for segregating the FED.

X-ray technology has the potential to successfully segregate higher-activity nimonic springs from mixed FED



Challenge: Removal of higher activity items from large quantities of FED waste

Solution: Waste segregation using appropriate screening technology

Technology: X-ray sorting plus established Eddy Current Separation technology

Benefits: Removing more than 95% of ILW items allows significant volumes of the bulk of waste to be treated and disposed of as LLW, and compaction of ILW FED to improve waste loading of disposal containers, saving significant costs

Status: Several successful trials conducted, with more scheduled

SLC: Magnox Ltd

Delivery partners: Informal support from SGM Magnetics and Applied Vibration Ltd

Website: www.sgmmagnetics.com and www.appliedvibration.co.uk

case study: HARWELL

Remote retrieval of contaminated water

Unforeseen levels of contaminated water had accumulated in some of Harwell's historic tube stores, located below ground and used for many years to hold radioactive waste requiring remote handling, known as remote-handled ILW.

Removal of the water from the five-metre deep narrow tubes required an innovative solution, involving collaboration between the site team and three supply chain companies.

The solution had to be compatible with the existing retrieval machine and waste disposal processes, ideally with as few steps as possible.

An early plan to use a vacuum system was rejected due to high volumes of water and significant programme schedule and cost implications. The eventual solution involved an absorbent system which can be lowered into the tubes to remove

water. The collaborating partners engineered the system so it would harden or "cure", forming a disposable product after absorbing the water.

A bespoke perforated bag containing water-absorbing material was combined with a specially developed polymer, combined with a rapid-setting cement to provide long-term stability under high doses of radiation and, critically, would meet criteria for disposal.

The product had no residual free liquids and fully immobilised the radionuclides in the cementitious matrix.

Since October 2014, 1,500 bags have been successfully deployed. The bags are transferred into stainless steel drums, along with other remote-handled ILW, and the contents encapsulated in grout before storage prior to eventual disposal.

Bespoke perforated bags with water-absorbing material are being used to retrieve contaminated water



Challenge: Removal of unforeseen levels of contaminated water from deep, narrow storage tubes

Solution: Nochar 960 and rapid-setting cement formulation plus perforated bags

Technology: Water-absorbent bags combined with encapsulation agents

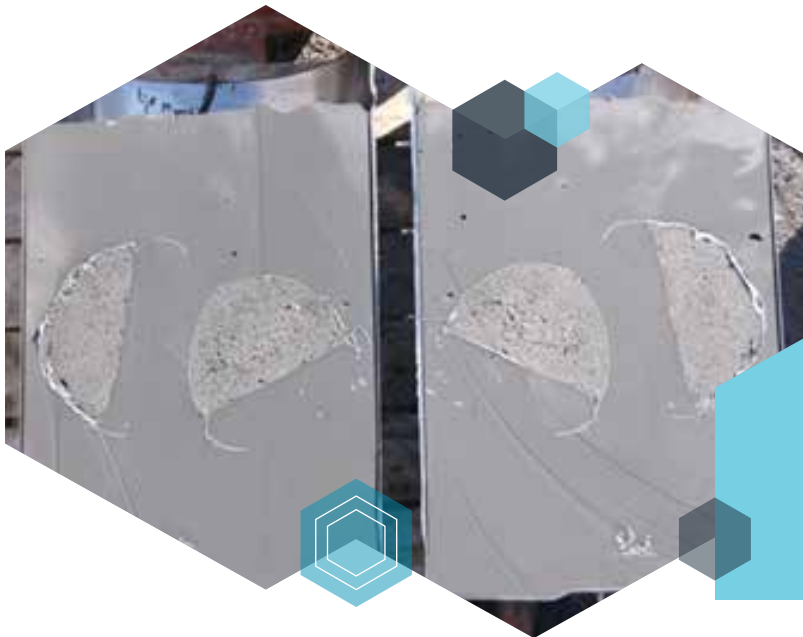
Benefits: Minimal modifications required to existing waste retrieval machine and treatment processes; acceptable costs; efficient; disposable product that complies with disposal criteria

Status: Fully deployed on site at Harwell

SLC: Magnox Ltd

Delivery partners: NSG Environmental Ltd, Nochar Inc and Rutpen Ltd

Website: www.nsgltd.com, www.nochar.com and www.rutpen.co.uk



case study: HARWELL

Fuel channel characterisation



A supplier collaboration on a series of projects is enabling characterisation of the fuel channels

A collaboration between the SLC and suppliers led to successful characterisation of 71 fuel channels in the core of Harwell's redundant British Experimental Pile Zero reactor known as BEPO.

A series of projects included:

- First invasive radiological survey of BEPO air inlet and outlet ducts
- Design and build a photon gamma characterisation probe
- Design and build a scaffold structure/containment to permit access to the shield-plugs and fuel channels on the BEPO fuel extract/air inlet face
- Design and build a shielded housing and lifting device to remove shield-plugs and deploy the probe.

The probe had to be deployed over almost 26ft, in a fuel channel with a diameter narrowing to less than 1.25ins, with a cable system resistant to snagging or damage, incorporating a camera with lighting. Simultaneously, the team worked on accessing the fuel channels and removing the shield-plugs.

A full-scale cardboard mock-up of a fuel channel demonstrated the constraints. A delivery/retrieval system was designed by the SLC and fabricated by a local SME. A major physical challenge was accessing the fuel channels on the reactor face, 13-29ft above a decommissioned hoist pit. A platform sealed by double-skin containment for radiological controls provided unrestricted access. Another challenge was deploying the probe and protecting the trailing cables. The initial concept proposed sections of pipe threaded together to push the probe into the reactor, a time-consuming manually intensive process.

A specialist company was identified that manufactured a bespoke laminated plastic that coils like a spring on one axis and uncoils in a rigid tube on the opposite axis. This minimised waste and avoided any need to join sections of pipe. The project confirmed the reactor has relatively little loose contamination and manageable dose: it is now much cheaper than previously thought achievable to decommission BEPO, with more conventional techniques and less onerous radiological controls.

Challenge: Securing unrestricted access to fuel channels inside Harwell's historic BEPO reactor, and understanding their internal condition through deploying a characterisation probe in difficult conditions

Solution: A series of projects to access the channels while ensuring radiological containment, design of a specialist probe together with shielded housing and lifting device for deployment of probe

Technology: Various custom-built solutions requiring careful deployment

Benefits: Accelerated characterisation of more fuel channels than anticipated at no extra cost, establishing low levels of contamination and significant reduction in future decommissioning costs

Status: Further development and on-site demonstration trials planned

SLC: Magnox Ltd

Delivery partners: Nuvia Ltd, Pipaway Engineering Ltd, SCA Group, Rolatube and on-site project team

Websites: www.nuvia.co.uk, www.pipawayengineering.co.uk, www.sca-group.com and www.rolatube.com



Geological Disposal Facility (GDF)



The Geological Disposal Facility (GDF) will house the UK's higher activity waste

Radioactive Waste Management (RWM), a wholly owned NDA subsidiary, is responsible for delivering a geological disposal facility (GDF) and provision of radioactive waste management solutions for the UK's higher activity radioactive waste.

In partnership with the Engineering and Physical Sciences Research Council (EPSRC) and the Natural Environment Research Council (NERC), RWM is funding a series of joint projects at PhD and post-doctoral level. Examples of these projects are shown opposite.

The NERC-related projects are at an earlier stage of development and look at:

- Processes in the rock masses close to a GDF
- Potential long-term impacts for people and the environment
- Reducing uncertainty in radiological risk assessments for people and wildlife.

The findings will expand RWM's scientific knowledge and help to ensure that the UK's nuclear waste inventory can be safely consigned to the GDF. A further important goal of the research is building expertise and collaboration that will yield long-term benefits. The collaborative work with EPSRC and NERC accounts for around 10% of RWM's research, the bulk of which is aimed at filling specific knowledge gaps.

Atomic and macro-scale studies of surface processes:

An investigation into how the surfaces of candidate materials in an engineered barrier system behave in a typical disposal environment; and the effect of any alteration processes on radionuclide/surface interactions.

Lead: Imperial College, London

Behaviour of UK-specific spent fuels:

To date, very little UK research has been carried out on the direct disposal of spent AGR fuel. This project aims to understand the long-term behaviour of spent AGR fuel in a GDF and contribute to the environmental safety case for disposal.

Lead: University of Cambridge

A Systems Approach For Engineered barriers (SAFE):

Absorbent bentonite clay will form part of the multiple protective barriers in the highly engineered GDF. This research focuses on improving understanding of the chemical and physical processes that occur at the barrier between the bentonite and surrounding rock mass, as well as between the bentonite and the waste canisters. The multi-disciplinary research team from six UK universities and the British Geological Survey is also exploring the effects of extreme temperatures on bentonite performance.

Lead: University of Strathclyde

The post-disposal behaviour of C-14 and irradiated graphite:

Irradiated graphite from reactor cores can release Carbon-14, a key radionuclide, primarily because of its potential to form gases. This project aims to improve understanding of how Carbon-14 is incorporated into the graphite; how it could be released and how its chemistry and microbiology influence potential movement.

Lead: University of Huddersfield

Corrosion processes in nuclear waste storage and GDF environments:

Researchers at the Universities of Birmingham, Manchester and Bristol and Diamond Light Source at Harwell in Oxfordshire are collaborating on a range of techniques to investigate the causes and speed of corrosion processes in waste packages.

Lead: University of Birmingham



Find out more

This brochure briefly outlines some examples of recent SLC investments in site-based R&D projects.


If you want to find out more, please visit our website www.nda.gov.uk or email: research@nda.gov.uk

Useful documents from NDA's website


- EGPR04 Technology Research Investment Process
- Research and Development 5 Year Plan 2014 to 2019
- NDA Research Board Terms of Reference
- Nuclear Waste Research Forum Terms of Reference
- EGG10 Technical Baseline and Underpinning Research and Development Requirements Rev5
- RWM Science and Technology Plan

Further information from SLC websites

- www.sellafieldsites.com
- www.magnoxsites.com
- www.llwrsite.com
- www.dounreay.com



The Nuclear Decommissioning Authority (NDA) is a Government-funded body, created in 2005 and tasked with overseeing clean-up of the legacy from the UK's pioneering post-war experiments with nuclear power. This includes the first nuclear power stations, built in the 1950s-1970s, experimental research centres, fuel-related facilities and the Sellafield complex, home to some of Europe's most difficult nuclear challenges.



Radioactive Waste Management (RWM), a wholly owned subsidiary of the NDA, has been established to build and operate a geological disposal facility and provide radioactive waste management solutions. It works with organisations across the UK that produce radioactive waste to help ensure that waste being packaged and stored now will be suitable for disposal.