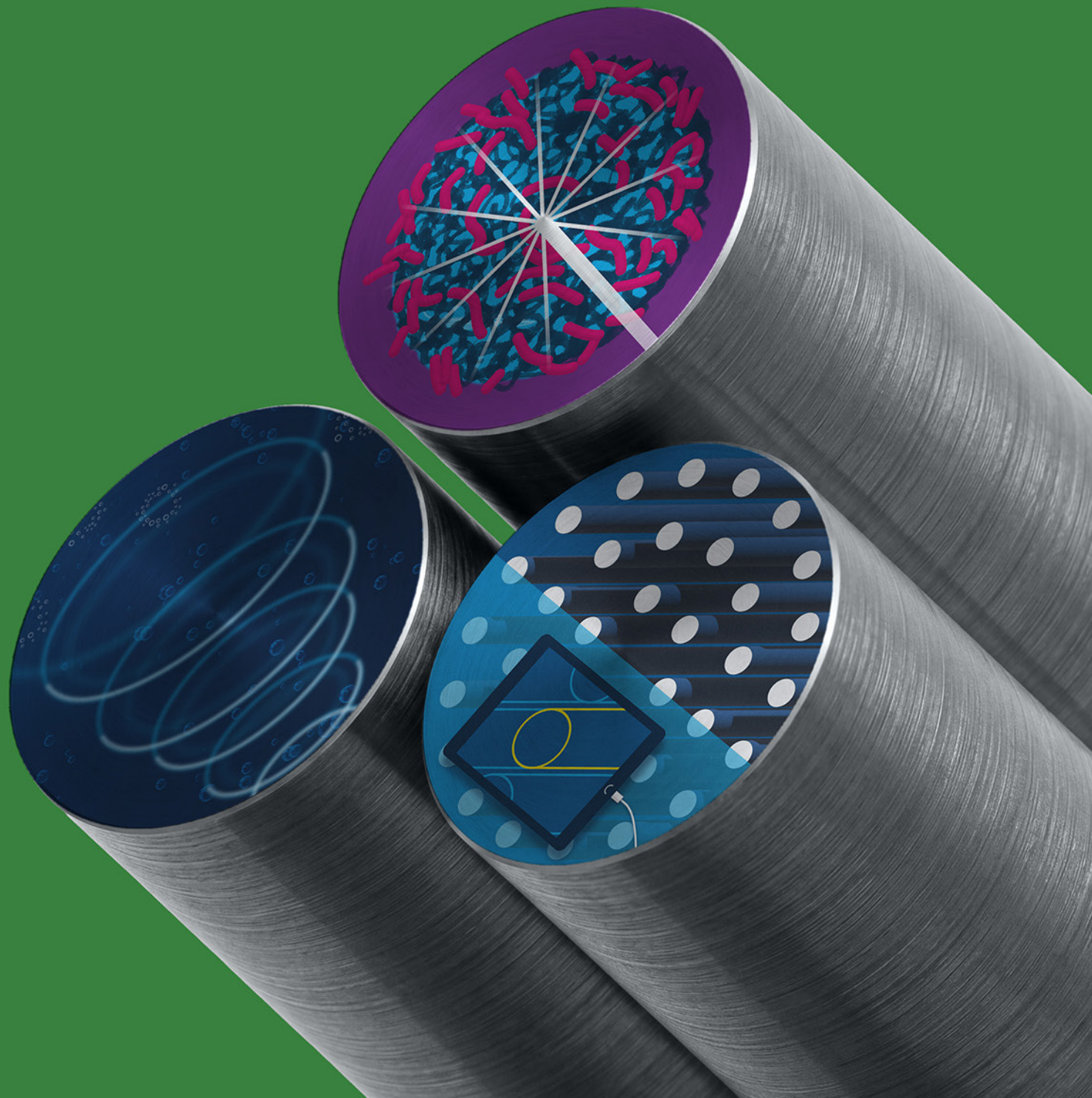


6 | Innovation

Innovation across our
Science and Technology Agenda



Innovation sits at the heart of UKNNL's mission. As the UK's national nuclear laboratory for fission, we are responsible for maintaining and advancing national nuclear capabilities and supporting industry to bring new technologies to market, a role strengthened by the 2024 Strategic Review.

Through a challenge-led approach, our bespoke innovation programme has developed technologies that address real operational challenges across the nuclear sector.

We have made, and continue to make, critical breakthroughs for the sector.

For this case study, we highlight projects which demonstrate the breadth and impact of UKNNL's work.

Together, they show how our Innovation team is not just solving today's technical challenges but also identifying, translating and applying new ideas in ways that create lasting value for the business, the sector and the wider world.

A novel approach
to decommissioning

Surface decontamination
using ultrasound
technology

Turning nuclear expertise
into cancer treatments

A novel approach to decommissioning

Challenge

Decontaminating nuclear waste is highly complex, particularly where grease, solvents, paints and radioactive residues adhere to pipework and equipment.

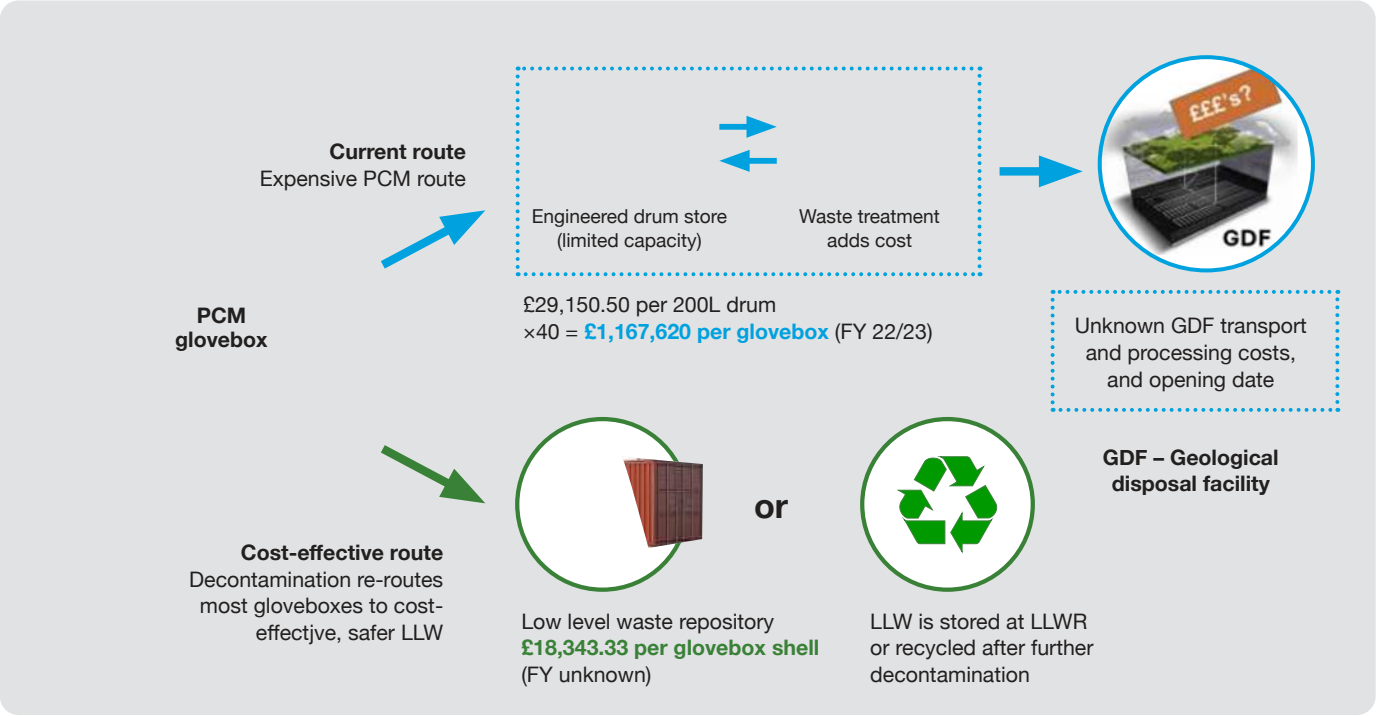
Irregular geometries, bends and restricted access make pipes especially difficult to clean, which

means that conventional methods often fail.

Although ultrasound technologies are proven in other industries (e.g. jewellery, medical devices, automotive), standard immersion bath systems cannot withstand the harsh chemical and radiological

conditions, nor can they be deployed effectively in nuclear plant environments.

A more robust, targeted ultrasound solution was therefore required to make the technology viable for nuclear decontamination.



Potential financial savings when using electrochemically assisted surface decontamination (EASD) to decontaminate gloveboxes rather than defaulting to the pPlutonium contaminated material route.

Solution

To address the challenges of decommissioning, UKNNL and partners have developed EASD – an innovative technique that uses an electric current to remove contaminated surface layers in situ.

The removed material can be captured in a liquid or gel, immobilised and safely managed through existing waste routes. The process leaves clean metal that can be reused or recycled, supporting faster and more environmentally responsible decommissioning.

At Sellafield, EASD has the potential to be particularly valuable as facilities enter post-operational clean-out (POCO).

It enables the effective decontamination of diverse metal components, including vessels, pipework, fume hoods and gloveboxes, and enables many items to be reclassified from costly intermediate-level waste (ILW) to low-level waste (LLW) which is much cheaper to process.

What the future holds

We have demonstrated EASD to have a major effect on contaminated gloveboxes.

Sellafield currently has more than 800 redundant units, 350 of which contain plutonium-contaminated material. Traditional ILW disposal costs around £1.2 million per glovebox, whereas EASD-enabled reclassification to LLW reduces this to around £28,000.

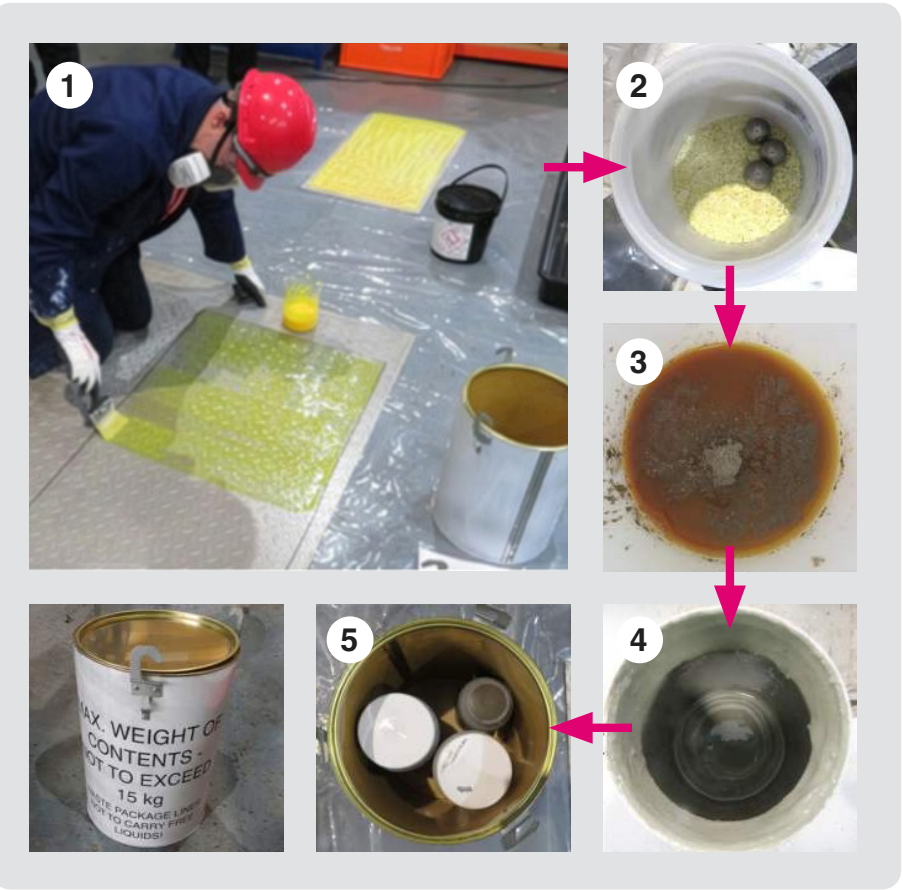
This represents potential savings of over £900 million, along with reduced storage pressures and improved waste management.

Operators at Sellafield have already been trained in the method, with further deployment planned.

We have also developed a waste conditioning method using a commercial decontamination gel, Aspigel 100E (from FEVDI/CEA, France), and delivered training on this alongside the EASD training at Sellafield.

Overall, EASD and related methods are powerful tools that can help to significantly accelerate UK decommissioning efforts while minimising environmental impact and reducing long-term liabilities.

EASD and Aspigel 100E training at Sellafield.
1. Sellafield operator applying the Aspigel 100E
2. Dried gel is collected and crushed
3. Spent gel is neutralised
4. Spent gel is encapsulated
5. All waste placed in MDGWS package



Surface decontamination using ultrasound technology

Challenge

Decontaminating nuclear waste is highly complex, particularly where grease, solvents, paints and radioactive residues adhere to pipework and equipment.

Irregular geometries, bends and restricted access make pipes especially difficult to clean, which means that conventional methods often fail.

Although ultrasound technologies are proven in other industries (e.g. jewellery, medical devices, automotive), standard immersion bath systems cannot withstand the harsh chemical and radiological conditions, nor can they be deployed effectively in nuclear plant environments.

A more robust, targeted ultrasound solution was therefore required to make the technology viable for nuclear decontamination.

Solution

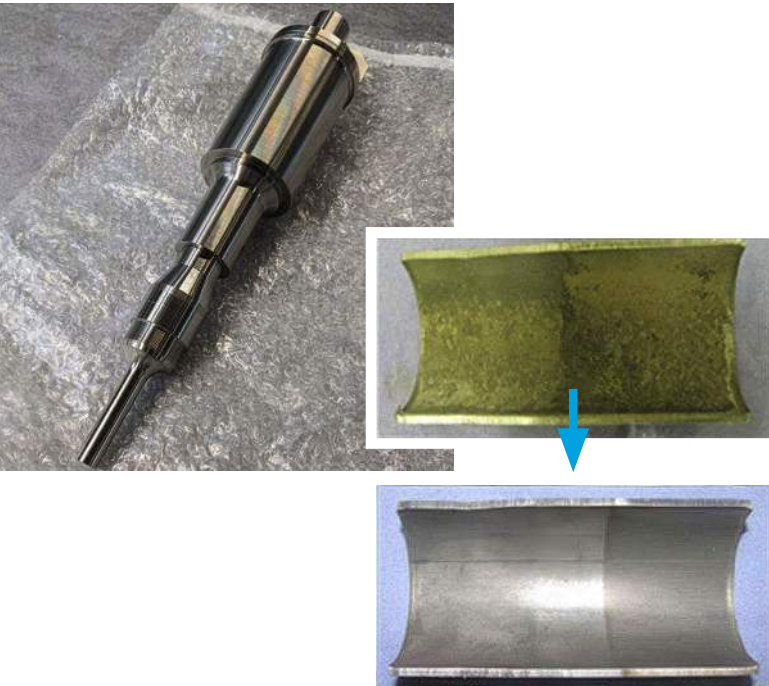
UKNNL's Innovation programme invested to develop a ruggedised ultrasound device that focuses cavitation energy directly onto contaminated surfaces, thereby enabling effective cleaning in confined and complex geometries.

Unlike immersion bath systems, the device can be precisely targeted and is engineered to withstand harsh chemical and radiological environments while remaining deployable in restricted plant settings.

We designed the system in collaboration with engineering colleagues and supply chain partners, and it was informed by operational experience at Sellafield and UKNNL sites.

Testing on both radioactive and heavily fouled non-radioactive pipework demonstrated strong performance across a range of contamination types, and the device is now chemically resistant and submersible in liquid.

This has enhanced the suitability of the technology for decontamination application in a range of settings.



What the future holds

The ruggedised ultrasound device can decontaminate materials in minutes, rather than the days or weeks required by conventional methods, delivering major efficiency gains for waste management operations.

Beyond surface cleaning, it can break down solids to keep them pumpable, thus reducing blockage risks and improving the performance of decontamination agents.

It also enables some wastes to be reclassified and recycled, significantly lowering both cost and hazard across the nuclear estate, and has the potential to become part of a wider decommissioning toolkit.

The programme has helped develop skills for the future workforce through early career talent and opened up new research opportunities, including novel oxidation chemistry applications.

Through the UKNNL Innovation programme, the ruggedised ultrasound device has been externally recognised through an award from the Government Office for Technology Transfer, validating innovation expertise and potential in this space.



Turning nuclear expertise into cancer treatments

Challenge

Almost 3.5 million people in the UK are living with cancer, and many could benefit from new targeted alpha therapies – treatments that deliver powerful radioactive particles directly to cancer cells while sparing healthy tissue. These therapies depend on specific radionuclides, but the UK currently lacks a domestic supply and therefore relies on imports.

Although suitable materials exist within UK nuclear facilities, they are typically stored in ways that make extraction difficult without disrupting decommissioning operations.

Solution

To address these difficulties, UKNNL’s Innovation team created REAPER (REcovery of Alpha Patient Enhancing Radionuclides), a modular system that extracts radionuclides from more accessible liquid locations, such as fuel storage ponds or process vessels. This approach reduces waste and radiation exposure and avoids the challenges of accessing solid waste stores.

Initial development included a 3D-printed prototype and the identification of an effective material for selectively capturing strontium-90 from radioactive cooling pond water at the Sellafield site. This strontium can then be processed in UKNNL’s active laboratories, to extract yttrium-90, which the radiopharmaceutical sector can incorporate into revolutionary cancer treatment drugs.

What the future holds

The REAPER programme is enabling the UK to establish its own long-term supply chain for medical radionuclides, potentially lasting centuries, owing to the volume of available spent nuclear fuel. It is also developing specialist nuclear and medical expertise, supporting PhD researchers and strengthening partnerships with institutions such as Medicines Discovery Catapult, Queen Mary University of London and King’s College London. Together, these efforts position the UK as a current and future leader in advanced cancer treatment development.

Summary

These examples show what can be achieved by applying scientific knowledge and investigation to problems across the nuclear sector.

From solving decommissioning challenges to repurposing our waste for positive purposes, such as improving human health, research programmes and collaborations like these continue to support UKNNL in achieving our purpose: nuclear science to benefit society.

Furthermore, such innovation programmes will continue to provide skills and experience for early-career researchers and contribute to the retention and development of our nuclear know-how.