



Groupwide Areas of Research Interest

Nuclear Decommissioning Authority

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Executive Summary

Areas of Research Interest (ARI) are a key way for government organisations to engage with the research community, identifying research and development (R&D) needs and promoting collaboration with academia, industry and across government.

This document summarises the Nuclear Decommissioning Authority (NDA) group's key areas of research interest, aiming to:

- build a dialogue around NDA's research interests with experts in academia, industry and the wider R&D community
- promote NDA's research interests in a way that gives experts the opportunity to get involved in our Research Development & Innovation (RD&I) activities
- communicate NDA's research interests to other government departments (OGDs) to foster cross government work around them
- form the basis of our forward NDA RD&I portfolio.

The report provides a high-level overview of identified research needs aligned with our [Strategy](#) [1] and how to find out further information.

This document is positioned alongside, and is complementary to, two other NDA publications: The NDA's Grand Challenges for Technical Innovation: Interim Update [2] and NDA Groupwide Technology Baseline Review [3].

This ARI is not a fixed forward research plan, but a strategic, high-level summary of priority research to help align external research with our mission. Funded research will be prioritised in line with Spending Review planning and prioritisation. Further information on how we publish progress on our RD&I activities is provided in Section [4](#).

1 Introduction

The Nuclear Decommissioning Authority (NDA) has a mission to decommission and remediate the UK's nuclear sites safely, securely and cost effectively, with care for our people, communities and the environment. Currently this covers 18 sites (as from April 2026, including facilities that were associated with the generation of electricity from nuclear power, the reprocessing of spent nuclear fuel and redundant experimental facilities associated with the UK's early civil and military nuclear programmes. This legacy is diverse and complex. Many facilities are unique, producing radioactive waste and spent fuel that no-one has ever dealt with before. We are also responsible for implementing both geological disposal of higher activity radioactive wastes and the UK nuclear industry's Solid Low Level Waste Strategy.



Figure 1 UK map of NDA sites

The NDA group is made up of the NDA, its four key subsidiary operating companies and a small number of specialist subsidiaries (for example, NDA Archives). The four key subsidiary operating companies are Sellafield, Nuclear Restoration Services, Nuclear Waste Services and Nuclear Transport Solutions.

The scope of the NDA group is set to grow, following arrangements agreed by the UK Government and EDF Energy for decommissioning Britain's seven Advanced Gas-cooled Reactors (AGRs). Over the coming decade, these stations will reach the end of their operational lives. Once defueling is complete, their ownership will transfer to the NDA, with first sites expected to pass to Nuclear Restoration Services from 2026 for decommissioning. This will allow the expertise developed through the decommissioning of Magnox stations to be applied to the AGR fleet, supporting a more efficient and consistent approach to their long-term clean up.

Looking ahead, the UK Government's strategy to develop new nuclear capacity through programmes such as Hinkley Point C, Sizewell C and potential [advanced nuclear technology](#) deployments will, in time, create a new generation of assets may also transfer to the NDA's remit for safe and secure decommissioning.

We have set out our long-term outcomes in our [NDA Strategy](#) [1] and identified the strategic challenges that require new knowledge or technology to resolve. Our funding and delivery priorities are set out in [The NDA Business Plan](#) [4] . [The Mission Progress Report](#) [5] provides transparency on performance and our progress towards our strategic outcomes that define success.

Research, development and innovation (RD&I) is fundamental to ensuring efficient and cost-effective delivery of our mission. Through strategic investment, collaboration and sharing of good practice, nationally and internationally, RD&I can improve safety, security and sustainability, thereby reducing costs, timescales and environmental impact. RD&I drives transformational change by helping us to:

- Understand the challenges and inform our strategy development
- Underpin our solutions and assure successful deployment
- Transform mission delivery.

Our objective is to transform and accelerate the delivery of our mission through research, development and innovation.

The NDA has a duty under the Energy Act (2004) to carry out and share research in nuclear decommissioning, promote and enable related innovation, share good practice and develop key skills. Collaboration across the NDA group and beyond is key to maximising impact, avoiding duplication and ensuring value for money. We are committed to developing the technical skills and expertise needed for the future, supporting our supply chain and ensuring rapid adoption of emerging technologies across the NDA group.

The majority of our RD&I is delivered by our operating companies and their supply chains. At the NDA, we maintain group-wide, well-established governance and advisory routes for RDI, and retain strategic oversight for RD&I across the group supporting prioritisation and a balanced portfolio. We also lead a strategic portfolio of needs-driven RD&I activities, targeting group-wide needs and opportunities to inform and develop strategy, encourage innovation and support key technical skills. Our RD&I activities are guided and governed through a defined set of documents that provide clarity on expectations and the framework for delivery.

Our [Technology Baseline Review](#) [3] outlines the NDA group technology baseline, the current technologies being deployed across the NDA group to deliver our decommissioning mission. It also identifies future technologies which are currently planned to be deployed, whilst our [Grand Challenges for Technical Innovation](#) [6] GCfTI and interim update [2] define key strategic challenges and assign aspiring targets that are intended to encourage technological developments, ultimately improving the way we work and helping to deliver our mission more effectively. Alongside these, our Areas of Research Interest (ARI) document outlines the

research questions and evidence needs that shape the research landscape and support alignment between academic, industry, and public sector partners with government priorities.

This ARI acts as a forward-looking statement of evidence and innovation needs. It identifies where additional RD&I is required to strengthen confidence in the data and assumptions that inform decisions, improve the efficiency of our processes and operations, and enable proportionate and sustainable delivery of our mission. It has been developed through review of published NDA and operating company research needs [7, 8], workshops with key NDA group stakeholders and the Nuclear Waste Decommissioning Research Forum and consultation with the NDA strategy team.

2 Structure: Strategic themes and our priority RD&I topics

This section sets out the framework that shapes our RD&I needs to support our delivery of the NDA mission. The framework provides a guide to research activity, the promotion of collaboration, and where focused investment can deliver the greatest value.

The ARI is organised across three complementary levels:

- **Strategic themes** – Which describe the core mission areas through which the NDA manages the UK’s nuclear legacy (Section [2.1](#)).
- **Grand Challenges** – Which set out bold, long-term ambitions for technical innovation and transformative change (Section [2.2](#)).
- **Priority research areas** – Which identify specific areas where focussed RD&I is required to address uncertainty, improve capability and support decision making (Section [2.3](#)).

These levels are supported within the framework by integrating a small number of cross-cutting themes (Section [2.4](#)) and a clear approach to collaboration (Section [2.5](#)) that are essential to maximising impact across all RD&I activities. Together these levels provide a clear line of sight from mission need, through to innovation ambition, to focused research activity.

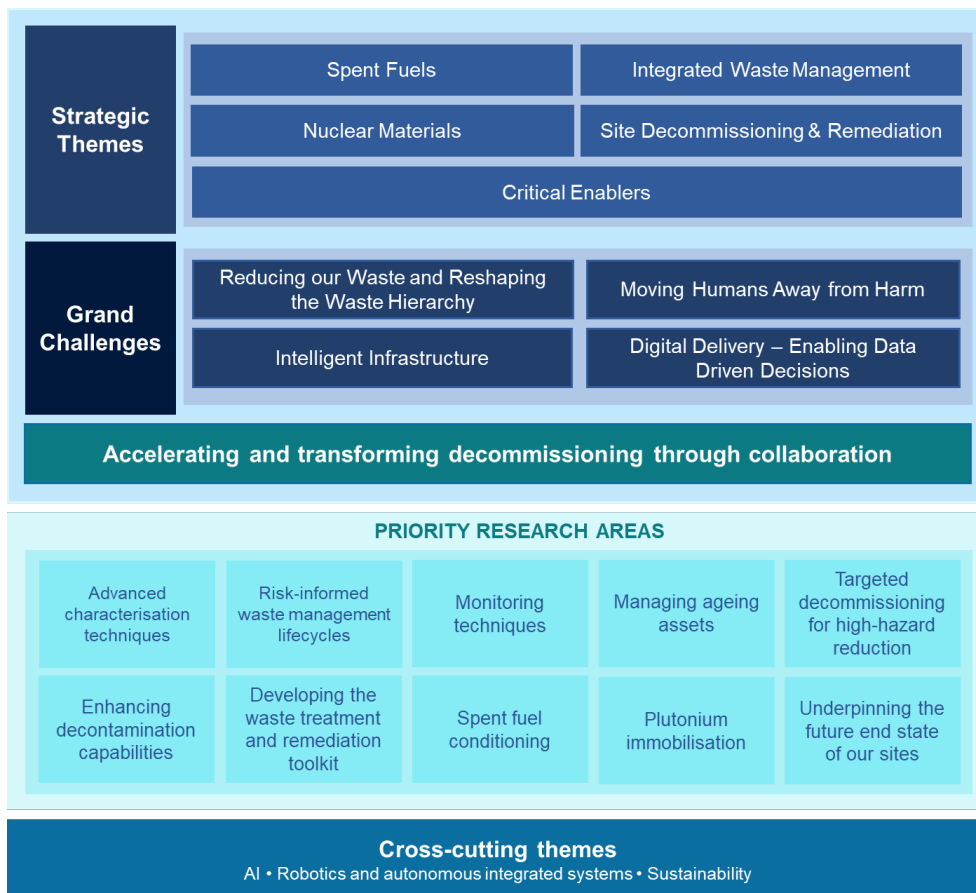


Figure 2: The NDA Research framework

2.1 Our strategic themes

We organise our activities into five strategic themes that support mission delivery. Together, they define a coordinated approach to managing the nation's nuclear legacy.

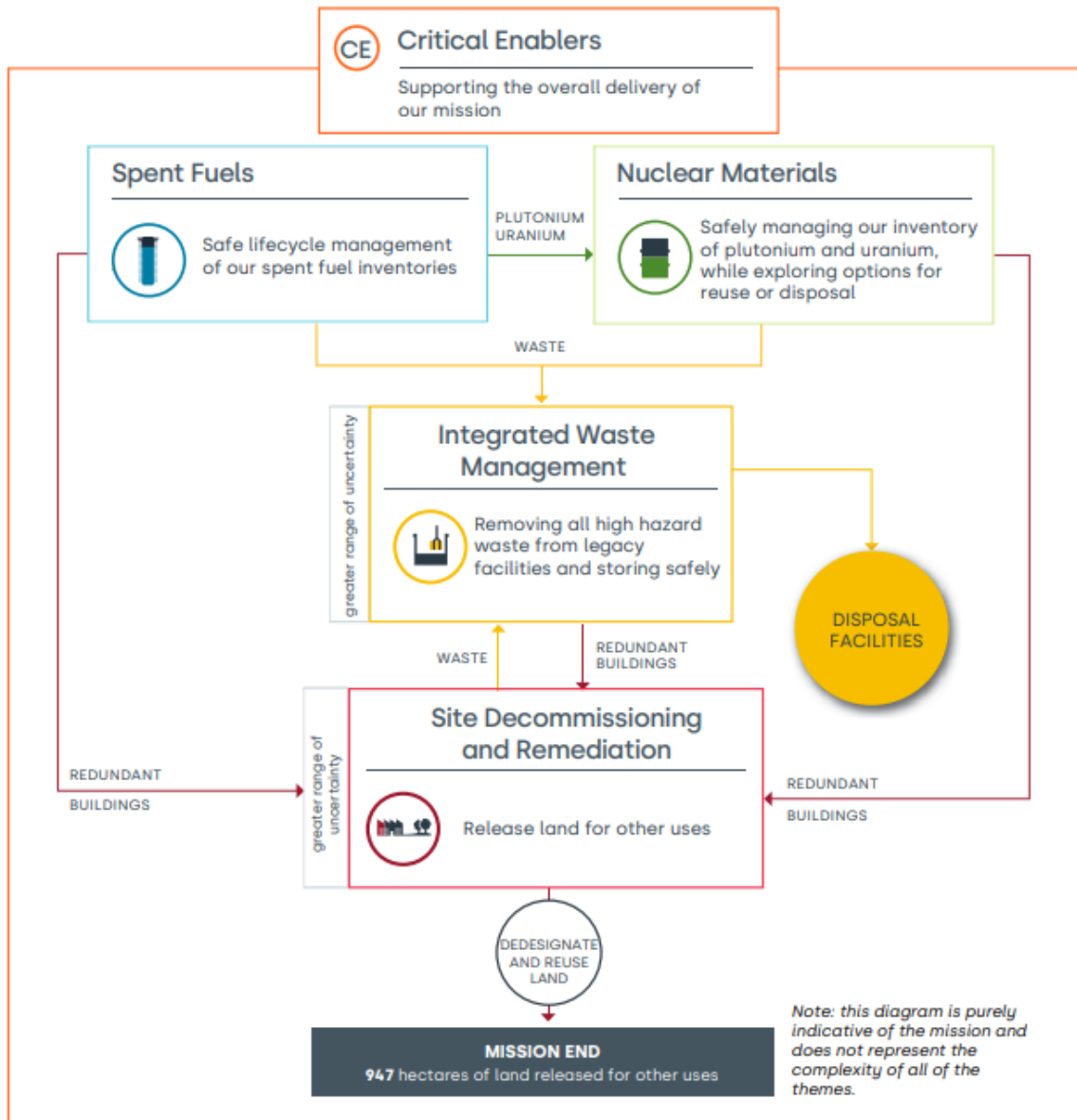


Figure 3: Our five strategic themes

The strategic themes, which are described in our [NDA Strategy](#) [1], encompass:

Site Decommissioning and Remediation (SDR)

We decommission redundant nuclear facilities, manage land quality and prepare sites for their long-term end states. This work involves reducing environmental risks, clearing hazardous materials and restoring land for potential reuse that benefits local communities.

Spent Fuels (SF)

Defines our approach to managing the diverse range of spent nuclear fuels for which we are responsible.

Nuclear Materials (NM)

Managing the safe storage and disposition on our sites of the UK's stocks of nuclear materials, including plutonium and uranium.

Integrated Waste Management (IWM)

Managing all forms of waste produced from nuclear operations and decommissioning activities, including waste retrieval from legacy facilities. Our approach ensures proper consideration of the Waste Hierarchy and the system as a whole, including preparations for final disposal.

Critical Enablers

There are fourteen Critical Enablers that support every aspect of our work, including our four Strategic Themes and any additional liabilities we receive from the wider UK nuclear enterprise. Some of these Critical Enablers reflect statutory duties set out in the Energy Act (2004) [9].

Each theme seeks to reduce hazards, protect the environment and deliver value to the UK.

Our Critical Enablers ensure we have a stable and effective operating environment with the essential capabilities, conditions and resources to deliver our mission. The fourteen Critical Enablers comprise:

- Health, safety and wellbeing
- Environment
- Security and resilience
- Cyber security
- Research, development and innovation
- People
- Asset management and continuous improvement
- Commercial and supply chain
- Information governance
- Socio-economics
- Digital, data and artificial intelligence
- Public and stakeholder engagement
- Transport and logistics
- International relations



Figure 4: Critical Enablers

2.2 NDA Grand Challenges for Technical Innovation

Innovation is vital to help address the wide-ranging challenges across the NDA group and we launched our Innovation strategy in 2022 [10].

In 2020 we published our [Grand Challenges for Technical Innovation](#) (GCfTI) to provide bold, cross cutting ambitions designed to accelerate progress on complex issues. Grand challenges are mission focused, ambitious initiatives used by governments to tackle complex, multi-faceted issues by driving momentum in targeted innovation, promoting collaboration and aligning innovation efforts. Our Grand Challenges provided a set of long-term aspirations out to 2030. The grand challenges were designed to provide clear articulation of desired outcomes, accelerate the development of key technologies, as well as encourage novel, creative

approaches to addressing them. The challenges included a set of ambitious aims for the half-way point in 2025, and an update on progress, learning and benefits to date is provided in our Interim Update [2]. Research will be essential to help us achieve these ambitions.

Table 1 Our Grand Challenges for Technical Innovation.

Challenge Theme	Interim innovation aims by 2025	Grand challenges for technical innovation (our 2030 aspirations)
Reducing our waste and reshaping the waste hierarchy	70% of all initial characterisation will be undertaken in situ, with results available within 24 hours, by 2025.	50% of waste, produced from decommissioning and clean-up, being recycled.
Intelligent infrastructure	All external monitoring of buildings should be carried out remotely by 2025.	All new buildings to be self-monitoring and energy neutral by 2030 - with a 50% lifetime cost reduction.
Moving humans away from harm	Remote decommissioning of gloveboxes by 2025.	A 50% reduction in decommissioning activities carried out by humans in hazardous environments.
Digital delivery – enabling data driven decisions	Accurate and up to date 3D virtual models (such as digital twins) exist for all key NDA sites by 2025.	All data captured at source which is then used to drive decisions, planning and training.

2.3 Our priority research topics

This ARI was developed through a collaborative, structured process to prioritise research challenges across the NDA group, informed by input from our stakeholders. The process drew upon existing NDA group research needs, plans and opportunities to review, consolidate and develop our priority challenges. This inclusive approach ensures that the ARI reflects the shared challenges and opportunities that have been identified by those responsible for delivering, regulating and supporting nuclear decommissioning and waste management across the UK. Priority research area themes are described in Section 3 and are based on a balance of the most urgent, most challenging and most beneficial research needs across our mission.

2.4 Accelerating and transforming decommissioning through collaboration

Collaboration across the NDA group and beyond is key to maximising impact, avoiding duplication and ensuring value for money. This includes working with UK government organisations, research councils, regulators, national laboratories, academia and the wider supply chain. Through collaboration and sharing of good practice, nationally and internationally, RD&I can improve safety, security and sustainability, thereby reducing costs, timescales and environmental impact and minimising duplication across NDA group and across government.

By aligning research priorities, sharing learning and undertaking demonstrator activities in operational environments, new technology and techniques can be translated more quickly into deployable solutions. This approach supports the development and adoption of technologies such as robotics, digital tools and advanced characterisation techniques, helping to reduce worker exposure, improve confidence in decision making and increase productivity. Sustained collaboration also supports the development and sharing of skills and technical capability needed to address long-term decommissioning challenges across the estate.

2.5 Cross-cutting themes

There are several cross-cutting themes that may apply across our priority research topics.

- The development and application of **Artificial intelligence (AI)** to transform how information is gathered, analysed, integrated and communicated. AI has the potential to support safer, faster and more cost-effective decision making by providing real-time insight and strengthening data interpretation, which in turn improves confidence in safety and environmental outcomes. Sound data governance will provide the framework needed for reliable, accessible and responsible use of information.
- Advances in **robotics and autonomous integrated systems** can improve our capability in challenging environments. Their development and deployment will be iterative and span multiple applications, reflecting both the breadth of decommissioning needs and an evolving understanding of what is achievable in practice. These technologies can enable the remote execution of tasks that would otherwise present access or exposure risks. When integrated with AI, they can improve efficiency and cost effectiveness, enhance situational awareness, and support more informed decision making as experience and capability mature over time. Activity in this area also aligns with, and is informed by our Grand Challenges, helping to focus on effort on shared, cross-cutting technical barriers and accelerate the translation of learning into delivery.
- Incorporating **sustainability** across all our RD&I activities will shape how we design, develop and deliver solutions. We need to be able to ensure that social, environmental and economic impacts are fully considered throughout our strategy and mission. We need to be ready to explore minimising environmental impact, recovering resources, reducing waste volumes and increasing the use of low-carbon materials to support efficiency and long-term value for society (see Section [3.2](#)). We also need to continue to develop sustainable capability in key technical areas, embedding learning and strengthening the behaviours and ways of working needed to support responsible, resilient and enduring delivery of the decommissioning mission.

In our Technology Baseline Review [3], we have identified three key **technology enablers** that have a broad application across our strategic themes – **characterisation, asset management and digital technologies, AI and robotics**. As could be expected, these are consistent with and complement many of the priority areas identified. **Table 2** identifies linkages between the technology enablers and areas of research interest to enable cross-comparison.

Table 2: Linkages between our Technology Baseline Review and ARI

Technology enablers [3]	Areas of research interest	Link
Characterisation	The development of technologies that improve how we measure, monitor and predict the properties of our waste, facilities and site environments is a common trend. The resulting enhanced datasets should be more accessible, enabling us to make better informed and more proportionate decisions on waste management, land remediation and environmental protection, and manage risk and uncertainties more effectively.	3.1 Advanced characterisation techniques 3.3 Monitoring techniques
Asset management	Our ARI reflects not only our need to continually strengthen the way we manage our assets, but also the timescales of our mission and ageing nature of some of our facilities. Research needs include better understanding of material behaviour and evolution, in addition to delivering data-led insights about our infrastructure.	3.4 Managing ageing assets
Digital technologies, AI and robotics	Our digital technology, AI and robotics needs are broad, covering: data platforms, artificial intelligence and large language models, robotic and autonomous systems, and underpinning activities to enable new technology adoption. Areas of research interest include: <ul style="list-style-type: none"> • developing fully integrated autonomous workflows • digital requirements for autonomy • assuring and qualifying AI and machine learning models for nuclear use • making AI co-pilots for nuclear operations, maintenance and retrieval decision making a reality • AI-based anomaly detection for sensors and digital twins 	ARI cross cutting themes AI and Robotics and Autonomous Integrated Systems

Raising the maturity (measured by the technology readiness level (TRL)) of technologies across NDA’s research challenge areas ensures that promising ideas progress into deployable, reliable and scalable solutions. Early-stage research and development, pilot and field demonstrations and mechanisms to accelerate the rollout of mature technologies (technology diffusion) all help to manage risk and strengthen RD&I delivery, with further benefit gained from embedding learning from deployment.

Cross-sector technology transfer delivers innovation by drawing upon proven approaches from other industries. Learning from, and adopting where appropriate, established practices can help close the gap with conventional decommissioning thus supporting proportionate delivery. It can also accelerate progress and improve performance when adapted to nuclear decommissioning, waste management and environmental management.

2.6 Using this document

This ARI document is intended to support collaboration between government, academia, industry and other research organisations. It sets out both the full thematic breadth of research areas across the NDA group and a focused set of priority RD&I challenges around which to ensure coordination. Together, these provide a strategic framework to guide research investment, shape funding programmes, and inform policy development.

It can be used to:

- **Align research proposals** with NDA group priorities and identify common areas of high impact.
- **Support dialogue** between researchers and policymakers on emerging evidence needs.
- **Inform funding decisions** by enabling researchers to clearly link proposals to NDA group priorities.
- **Guide cross-sector collaboration** by highlighting shared challenges and opportunities.

This ARI has been intentionally developed at the strategic level. While it captures the full breadth of research areas relevant to the mission, it does not aim to provide detailed RD&I requirements. Instead, it offers directional guidance on the research considered most valuable at the time of assessment, rather than an exhaustive specification.

Our Areas of Research Interest is positioned alongside our *Grand Challenges for Technical Innovation: Interim Update* [2] and *Technology Baseline Review* [3] documents. These documents present a triad of technology requirements, research interests, and forward-looking ambition (see **Figure 5**).

The Technology Baseline Review sets out our current capability and constraints, the Grand Challenges articulate long-term ambitions, and the Areas of Research Interest identify the research and evidence needed to move the baseline toward our ambitions. The Grand Challenges offer a complementary mechanism, providing shared aspirations that communicate a direction of travel against which innovation can align.

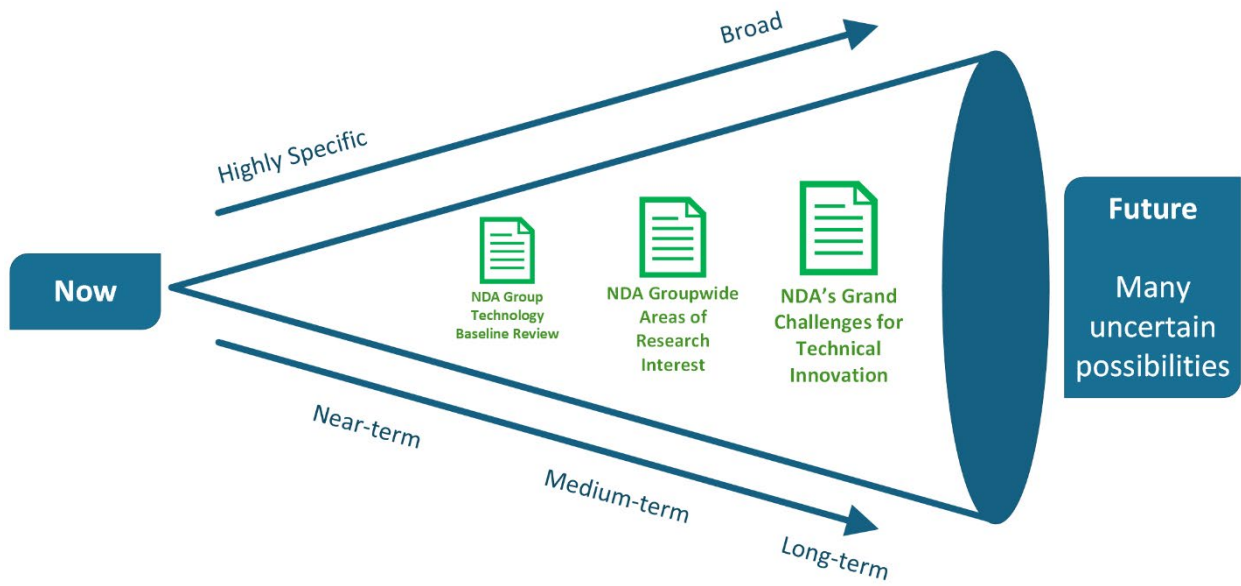


Figure 5: NDA Groupwide Areas of Research Interest and how it interacts with other group R&D documents.

2.7 Other relevant ARIs and publications

This ARI also directs readers to further resources for wider context and deeper insight. This includes:

- [Clean Energy Superpower Mission Areas of Research Interest 2025](#) [11]
- [Sellafield Areas of Research Interest 2024](#) [8]

More information on government Areas of Research Interest can be found on [gov.uk](#) [12]. Guidance on writing and using ARI is provided [here](#) [13]. ARIs for all of the UK governmental bodies, including NDA, can be found in the [ARI database](#) [14].

3 Priority research areas

This section outlines the ten priority research areas for the NDA group. The challenges represent areas where more coordinated, groupwide and external collaborative effort could deliver the greatest impact. While they form a focal point of research activity, other research topics remain important and continue to contribute to the safe, efficient and sustainable delivery of NDA's mission.

3.1 Advanced characterisation techniques

Characterisation underpins effective decision making across the NDA estate by providing the evidence needed to understand wastes, facilities and site environments, develop decommissioning plans and remove uncertainty. Improving the speed, quality and representativeness of characterisation data, alongside better management and communication of uncertainty will strengthen confidence in waste sentencing, decommissioning and remediation strategies and long-term performance assessments.

3.1.1 Advances in characterisation

Challenge: How can advances in characterisation improve our understanding of our wastes and our facilities to ensure fit for purpose decommissioning plans?

Strategic Themes: IWM, SDR, SF, NM

Improved assay and analytical techniques (both destructive and non-destructive) strengthen the quality, reliability and acquisition speed of information on the radiological, chemical and physical properties of wastes, facilities and site environments. Improved characterisation where access is constrained, contamination is poorly defined or where representative sampling is challenging, will enable more proportionate decision making and support better alignment with long-term lifecycle requirements.

Areas of interest include:

- Solutions that can be deployed in situ and/or remotely, with results available quickly to support timely decision making.
- Faster off-site analytical techniques to increase characterisation capacity.
- Improvements in data acquisition speeds, lower detection limits and wider performance envelopes.
- Approaches that support the design of remediation strategies for legacy contamination, including poorly defined or inaccessible contamination, and improve understanding of the influence of changing environmental and climatic conditions.
- Techniques to support characterisation of a range of radiological and non-radiological contaminants, including persistent organic pollutants (POPs) such as per- and polyfluoroalkyl substances (PFAS), asbestos, oils, and heavy metals.

- Sampling tools and techniques that can be deployed effectively in a range of environments (including confined spaces, high radiation areas and by remote operation) to ensure consistent, representative sampling.
- Approaches that help quantify and reduce uncertainty, complementing the more detailed focus on uncertainty management set out in Section [3.1.2](#).
- Techniques that enable characterisation of spent fuels (e.g. AGR, Exotic) for storage
- Improved accessibility of characterisation data, supporting improved data insight.

3.1.2 Improvements in uncertainty management

Challenge: How can improvements in uncertainty management enable more proportionate, risk informed decision making?

Strategic Themes: IWM, SDR

Effective management of uncertainty is essential to achieving proportionate, risk informed waste management while maintaining high standards of safety and environmental protection. This challenge focuses on how uncertainty associated with characterisation data is interpreted, understood, communicated and used within decision processes, complementing the data quality improvements set out in Section [3.2.1](#). Research may include the exploration of methods to:

- Reduce unnecessary conservatism in characterisation, waste sentencing and long-term performance assessment, enabling waste to be managed higher up the waste hierarchy where appropriate.
- Identifying appropriate opportunities to reduce conservatism in waste packaging advice for final disposal.
- Improve the traceability and transparency of the data, assumptions and judgements that underpin decisions.
- Support proportionate, evidence-based planning that balances safety, environmental protection and value for money while sustaining regulatory confidence.
- Use of AI tools to support risk management.

Clearer communication of uncertainty will improve transparency for regulators and communities, supporting more consistent decisions across the waste lifecycle.

3.2 Risk informed waste management lifecycles

Risk informed waste management across the full lifecycle relies on proportionate planning, robust evidence and approaches that are informed by the risk posed by the waste, rather than solely by its radiological classification. This approach supports decision making that seeks to deliver the best outcome for the waste, by optimising waste management routes based upon conventional, chemical and radiological risks, alongside consistent application of the waste hierarchy. Advances in planning approaches, decision support tools, materials, waste package design and disposal options can strengthen confidence in decision making, improve operational reliability and enable more sustainable lifecycle outcomes.

3.2.1 Support to waste management planning

Challenge: Which techniques and technologies can improve decision making and optimisation in waste management planning across the lifecycle?

Strategic Themes: IWM, SDR

Techniques and technologies that strengthen waste planning across the lifecycle by improving such as increasing speed, accuracy, speciation capability or scale of delivery. Improved identification, forecasting and optimisation will support more consistent application of the waste hierarchy. Examples could include research focused on automated and digital tools, including predictive modelling and decision-support systems to inform proportionate and risk-based planning. Approaches enabling reuse, recycling and recovery of materials in line with existing infrastructure capabilities and waste management pathways could contribute to a circular economy (see Section [3.2.2](#)). Whilst characterisation is addressed separately within Section [3.1](#), advances in that area will also inform and enhance approaches described here.

3.2.2 Moving up the waste hierarchy

Challenge: Which approaches could enable us to safely reuse or recycle wastes that pose very little hazard or risk or present an inherent value and could therefore provide opportunities to manage higher up the waste hierarchy?

Strategic Themes: SF, NM, IWM, SDR

Research focused on applying waste hierarchy principles [15], including the recovering and reuse of materials, energy and resources from the waste inventory, can support sustainable mission delivery and minimise disposal, where this can be achieved safely and proportionately. Applying circular economy principles within waste management can offer opportunities to derive wider environmental, operational and lifecycle benefit from wastes.

Approaches should include both radioactive and conventional waste streams

- Recycling and repurposing approaches for wastes including scrap metals, soil, concrete, rubble, aggregates and other bulk materials, that transform existing waste streams into compliant materials that can be used for other purposes.
- The recovery of radionuclides or radioactive metals from specific waste streams, where strategically aligned, technically feasible and regulatory frameworks permit, e.g. carbon-14 from graphite.
- Energy and water recovery technologies that improve resource efficiency and reduce environmental impact.
- Better ways to assess lifecycle benefits in comparison to additional secondary and tertiary waste generation, increasing complexity and diversity of waste streams.
- Investigating reuse options for the NDA uranium inventory, for example as a feed inventory for a future plutonium immobilisation product (Disposal MOX).

In line with UK government policy, plutonium is managed through dedicated disposition and immobilisation programmes (See [3.9](#)). Therefore, this topic does not include consideration of plutonium management routes.

3.2.3 Improved performance and operational reliability

Challenge: Which materials, processes and manufacturing methods can improve performance and operational reliability in nuclear environments?

Strategic Themes: NM, IWM, SDR

Novel or improved materials and manufacturing techniques offer opportunities to enhance the performance and operational reliability of structures, systems and components used across the waste management lifecycle. With increasing understanding around “forever chemicals” such as per- and polyfluoroalkyl substances (PFAS,) there is also a need to transition to alternative materials for mechanical components such as seals or personal protective equipment (PPE). Our interest is where such innovation will support risk reduction, particularly in high radiation environments. Examples include innovation in protective coatings, material repair methods, and additive manufacturing. Improved material performance can also support hazard reduction and improve the reliability of components and systems over their lifecycle.

3.2.4 Developing optimised waste packages

Challenge: How can we optimise waste packages for transport, storage and disposal to improve cost effectiveness whilst ensuring safety standards?

Strategic Themes: NM, IWM, SF

Optimised waste packages can improve safety, resilience and lifecycle assurance. Research may include exploring package designs, engineered features or validation approaches that support improved manufacturability, volume reduction, handling, transport, cost-effectiveness and long-term performance. These improvements can strengthen confidence in long-term storage and disposal outcomes.

3.2.5 Developing more sustainable waste packages

Challenge: How can materials, manufacturing methods and treatment approaches be improved to deliver more sustainable waste packages for transport storage and disposal?

Strategic Themes: IWM, SF

Developing more sustainable packaging approaches can reduce environmental impact of both the manufacturing process and waste package materials while maintaining required performance. Research may include low carbon container manufacture, alternative encapsulants and treatment methods (e.g. thermal treatment) that minimise secondary wastes and support resource efficiency. Opportunities to reduce material use and strengthen lifecycle sustainability are of particular interest. NDA group is interested in conducting work to substantiate lower carbon cementitious encapsulants, including blended cements such as lower-carbon Portland composite cement (CEM II) and other formulations that demonstrate compatibility with existing waste management routes.

3.2.6 Underpinning disposal

Challenge: What are the advances in geological disposal science technology that will underpin the robust design, regulatory approval and delivery of the UK's geological disposal facility?

Strategic Themes: IWM

A crucial requirement for disposal of our most hazardous radioactive wastes is the availability of a geological disposal facility (GDF). A cornerstone of Nuclear Waste Service's role in the group is the development of a suitable facility. An essential component underpinning the GDF is the foundational understanding of conditioned wastefrom evolution on timescales relevant to geological disposal and the post-closure period. Research is needed to enable a robust GDF design and develop an associated Environment, Safety, Security, and Safeguards (E3S) Case.

Areas of interest include:

- Improved understanding and characterisation methodologies of the natural system and its evolution over timescales relevant to geological disposal.
- Improved understanding of contaminant pathways and transport mechanisms associated with geological and engineered barrier systems.
- Improved understanding of engineered barrier system materials for both high- and low-heat generating wastes (HHGW, LHGW).
- Development of experimental methodologies and analytical tools for the accelerated testing of wastefrom evolution under geological disposal conditions.

- Development of cost-effective tunnelling, excavation, fabrication and construction technologies, including tunnelling techniques, liners and underground heating, ventilation and air conditioning.
- Reducing conservatism / constraints linked to disposal within existing and future disposal facilities.

3.2.7 Alternatives to existing disposal routes

Challenge: Under what conditions do on-site, in situ or near-surface disposal routes deliver a demonstrable lifecycle benefit, and how should facility design, operation and closure be adapted to realise that benefit?

Strategic Themes: IWM, SDR

There is a considerable amount of research underway by Nuclear Waste Services to support the delivery of existing disposal approaches, including the development of a GDF and the continued operation of established near-surface facilities such as the Low Level Waste Repository. The 2024 UK policy framework for Managing Radioactive Substances and Nuclear Decommissioning [15] also includes near-surface disposal (NSD) as an option for some suitable, less hazardous ILW in England and Wales (previously in Scottish policy only). The exploration of alternatives to these existing approaches may offer lifecycle benefits. This includes in situ or on-site disposal and other forms of near-surface disposal, and the associated technologies and techniques that would improve the design, construction, operation and closure of disposal facilities. Stronger evidence of long-term environmental resilience will support assessments of alternative disposal approaches, including technically underpinned models that predict how alternative disposal approaches will evolve over prolonged periods.

3.3 Monitoring techniques

Monitoring plays a central role in maintaining safe, compliant and resilient storage conditions across the NDA estate. Continued advances in monitoring methods, sensor technologies and data integration will strengthen our ability to track package and facility conditions over time; identify emerging issues early; enable proportionate, evidence-based responses; and improve confidence in long-term stewardship decisions. Innovation in the monitoring of effluent streams

will reinforce environmental protection and ensure ongoing compliance with regulatory expectations. Long-term monitoring of ageing assets is addressed in Section [3.4](#).

3.3.1 Remote and in situ monitoring methods for stored inventories

Challenge: Which remote and in situ monitoring methods can provide early warning of altered behaviour and degradation in stored fuel, nuclear materials and radioactive waste packages during interim storage?

Strategic Themes: SF, NM, IWM, SDR

Developing in situ and remotely deployable monitoring techniques strengthens our assurance of the condition of the inventories in interim storage. Challenges include high-radiation environments and timescales. Research will focus on early detection of corrosion, gas generation and physical degradation, using autonomous sensors and data-driven diagnostics to quantify evolution over extended periods. Smarter sensing and integrated data streams that support early intervention can improve hazard reduction. Better understanding of wastefrom evolution during storage will also support disposal.

3.3.2 Store definition, monitoring and control

Challenge: What approaches are needed to define, monitor and control store and pond environments, so that safe operating envelopes are maintained and deviations are detected and managed effectively over extended periods of time?

Strategic Themes: SF, NM, IWM, SDR

Improving our understanding of how store and pond environments evolve under varying conditions (such as humidity, temperature, chemistry and ventilation) will strengthen the evidence base for long-term storage performance. Research focused on real-time monitoring, control systems and automated alerts will enable the early detection of deviations from expected environmental conditions. Innovation in these areas will help ensure that the right interventions are made first time, improve safety and deliver cost benefits by addressing problems before they can escalate, enabling proactive interventions through early detections and trending analysis and inform development of best practice guidance.

3.3.3 Integrated modelling of spent fuel, waste packages and store environments

Challenge: How can monitoring data from packages and store environments be integrated with predictive modelling to improve our understanding of long-term behaviours in interim storage?

Strategic Themes: SF, NM, IWM, SDR

Integrating environmental and package monitoring data with predictive modelling will improve forecasting of the long-term inventory of waste and fuel evolution. Research may include approaches that validate measured parameters against degradation models, refine predictions of long-term performance and support the development or confirmation of safe operating envelopes. This combined understanding will strengthen evidence-based planning, inspection and decision making across interim storage and will contribute to disposal.

3.3.4 Monitoring techniques for contaminated land and groundwater

Challenge: Which monitoring approaches can provide reliable, long-term and in situ insight into the behaviour of land and groundwater contamination, reducing reliance on intrusive sampling while supporting proportionate decision making?

Strategic Themes: SDR

Improved monitoring of land and groundwater contamination is required to move beyond periodic, intrusive sampling and towards approaches that provide continuous or near real-time evidence of contaminant presence, migration and change over time, across diverse environments. Advances in in situ, remote and non-invasive monitoring will strengthen confidence in site models, support earlier detection of change, reduce uncertainty in long-term stewardship and enable more proportionate remediation and end state decisions while maintaining environmental protection.

3.3.5 Novel sensor technologies for real-time effluent monitoring

Challenge: Which sensor technologies can support real-time monitoring of effluent streams?

Strategic Themes: IWM, SDR

The development of robust, in-line sensors will support real-time process control and improved effluent management. Research priorities include sensors capable of detecting parameters such

as pH, oxidation-reduction potential, conductivity and radioactivity across a range of operational contexts including high-radiation and acidic environments. Emerging technologies such as self-calibrating and autonomous sensors could deliver cross-group benefits by supporting real-time operational decision making for effluent sentencing and resource recovery, while reducing manual sampling requirements. These innovations could improve responsive operations and strengthen environmental assurance.

3.4 Managing ageing assets

With a mission to clean up the UK's earliest nuclear sites and current plans indicating it will take more than 100 years to complete, the management of ageing assets is a key area of interest for us. Approaches are needed to further our understanding of their condition and improve responsiveness to emerging issues to support safe, long-term stewardship. Advances in autonomous monitoring, improved insight into degradation mechanisms and more effective use of asset data can reduce operational burden and enable more proportionate risk informed decisions.

3.4.1 Autonomous monitoring and management

Challenge: How can we autonomously manage and monitor our ageing assets?

Strategic Themes: SDR, IWM

Advances in autonomous and intelligent technologies present opportunities to transform the monitoring and management of assets and buildings more safely, efficiently and effectively. Future solutions may include self-monitoring and self-reporting systems for assets, such as waste packages, stores and containment structures supported by predictive diagnostics, adaptive control, and potentially self-repair capabilities. Predictive capabilities can reduce operational burden and improve safety performance.

3.4.2 Understanding and predicting degradation through plant condition assessment

Challenge: How can we better understand the impact that plant conditions have on our ageing assets?

Strategic Themes: SDR, IWM

Developing improved inspection, sensing and analytical tools will help to quantify how environmental and operational conditions influence asset degradation and structural integrity over time. Improved understanding of these degradation mechanisms (informed by both historic evidence and ongoing inspection) can be combined with advanced monitoring data, digital modelling and predictive analytics to support condition-based management approaches. This integrated evidence base will enable earlier detection of emerging issues and more

proportionate, risk informed maintenance and decommissioning decisions on maintenance, post-operational clean out (POCO) and decommissioning.

3.4.3 Data-driven decision making for asset management

Challenge: How can we manage our assets to support decision making and safe long-term stewardship?

Strategic Themes: SDR, IWM

Innovations in data-driven asset management and decision support systems will strengthen the prioritisation of decommissioning activities and optimise the use of resources. Improved approaches to asset care and maintenance will support efficient and assured management of facilities that are in long-term quiescent states. A stronger evidence base will support long-term stewardship and improved resilience.

3.5 Targeted decommissioning for high-hazard reduction

Targeted decommissioning (prioritising the reduction of higher hazards in facilities and areas of greatest risk) requires approaches that help address specific technical challenges across a range of legacy facilities. Improved understanding of waste characteristics, alongside advances in retrieval, decontamination and supporting technologies can inform proportionate actions and reduce risks during POCO and decommissioning and dismantling (D&D). These developments will support a 'lead and learn' approach by enabling learning to be applied across facilities, improving confidence in safe, efficient and cost-effective progression towards final end states.

3.5.1 Advanced retrieval and handling techniques

Challenge: How can advances in retrieval techniques support decommissioning activities in high risk, high hazard environments and improve reliability?

Strategic Themes: IWM, SDR

Novel retrieval systems, including remote and robotic solutions, present an opportunity to safely recover materials from challenging or highly active areas. Research will focus on remote and robotic technologies, compatible with existing facility/vessel access points and adaptable to a range of legacy plant configurations. Developments in this area will seek to reduce operator exposure, improve precision and reliability and support the safe progression of decommissioning activities. Integrating with new tools such as AI will also support data driven decision making. Consistent and safer delivery across the group can be achieved through improved retrieval capability that targets specific hazards whilst leaving surrounding structures intact.

3.5.2 Technologies supporting post-operational lifecycle phases

Challenge: Which technologies best support a range of post-operational lifecycle phases, including but not limited to POCO and D&D, while reducing dose and secondary wastes?

Strategic Themes: IWM, SDR

A wide range of novel technologies and techniques can support efficient transition from operations to decommissioning. This includes broad innovations such as robotics and autonomous systems, as well as targeted solutions for specific technical or operational challenges, including the dismantling of alpha-contaminated structures, gloveboxes and pipework. Research in this area will focus on scalable approaches that improve safety, efficiency and value across the full lifecycle of nuclear facilities, improving confidence as sites progress towards final end states. Areas such as advanced sorting and segregation of complex wastes, increasing autonomy of systems and integrating multiple remote and robotic platforms are of interest.

3.5.3 Understanding and managing graphite wastes

Challenge: How can we manage our graphite wastes more effectively?

Strategic Themes: IWM, SDR

Improving our understanding of how the inventory, distribution and long-term behaviour of radionuclides within reactor graphite evolves is critical to the proportionate management of a significant and challenging waste stream. Enhanced characterisation, alongside research into treatment, radionuclide recovery and volume reduction techniques will strengthen the evidence base to support the optimisation of packaging, storage and disposal strategies. While geological disposal remains the baseline assumption, improved understanding may enable more efficient and credible management approaches that reduce uncertainty, improve disposability and support long-term waste route optimisation.

3.6 Enhanced decontamination capabilities

Decontamination plays a critical role in enabling safe, proportionate and efficient progression through the post operational lifecycle phases across the NDA estate. As sites transition towards POCO, D&D and long-term site stewardship; decontamination activities increasingly influence project risk, cost and waste arisings. Techniques and capabilities that can address existing and challenging contamination while reducing the generation of secondary wastes and ensuring disposability will support progression through post operational phases. Advances in integrated robotics and remote systems offer significant opportunities to reduce risk to the workforce;

however, their sustained use is dependent on effective decontamination approaches that enable redeployment. The value delivered by innovations in this area will depend on the extent to which they can be deployed within existing operational environments.

3.6.1 Management of heels and residues

Challenge: How can we more effectively manage heels and residual contamination in vessels, tanks and pipework to enable proportionate cleanout, reduce secondary waste generation and avoid disproportionate dose, cost and programme impacts?

Strategic Themes: IWM, SDR

Heels (residual inventories or contamination remaining after bulk retrieval) and residual contamination remaining in vessels, tanks and pipework present a persistent challenge across the NDA estate and can impact risk, cost and schedule during decommissioning projects. Improved techniques to remove, immobilise or stabilise heels and residues will support more proportionate cleanout, reduce lifecycle impacts and enable earlier progressions to decommissioning and dismantling while maintaining safety and environmental protection.

3.6.2 Low effluent and dry decontamination techniques.

Challenge: What low effluent and dry decontamination techniques can deliver effective contamination control whilst minimising secondary wastes or downstream effluent treatment capability?

Strategic Themes: IWM, SDR

The development and qualification of low effluent and dry decontamination techniques, including thermal or surface-based approaches may enable more flexible and proportionate decommissioning. The associated reduction in secondary wastes or downstream treatment with

alternative approaches will support a reduction in lifecycle impacts compared with active effluent systems.

3.6.3 Decontamination of remote and autonomous systems

Challenge: How can we reliably and proportionately decontaminate robotic, remotely operated and autonomous systems to enable their repeated deployment across hazardous environments?

Strategic Themes: IWM, SDR

The use of remotely operated technologies, including fixed and mobile robots, unmanned aerial vehicles, quadrupeds and other autonomous platforms support the reduction in worker exposure during inspection, retrieval, decommissioning and monitoring activities. Their deployment in highly contaminated, constrained and potentially poorly characterised environment means that contact with radioactive and chemical contaminants is unavoidable. Decontamination approaches that are specifically designed for complex robotic systems will support sustained robotic deployment, reduce waste and asset losses and underpin NDA's commitment to remove people from harm and deliver proportionate, efficient decommissioning.

3.6.4 Facilitating the deployment of decontamination techniques.

Challenge: Which decontamination techniques can be designed and adapted to deploy effectively within existing systems, infrastructure and downstream waste processing and waste management routes?

Strategic Themes: IWM, SDR

Decontamination approaches that show effectiveness often fail to deploy at scale due to incompatibility with existing plant layouts, access constraints, safety cases or downstream effluent and waste management arrangements, including disposability of decontamination agents. Innovation in decontamination approaches and techniques that are deployable within current operational environments without disproportionate modification or additional infrastructure and can integrate with legacy infrastructure will enable earlier deployment, reduce programme risk and cost and help ensure that decontamination delivers safety and lifecycle benefits. Adaptation of solutions from other industries is of interest.

3.7 Developing the waste treatment and remediation toolkit

Developing an effective waste treatment and remediation toolkit is essential to manage the full spectrum of wastes, including those that are hard to treat, condition or immobilise. Continued innovation in immobilisation, thermal treatment, effluent treatment, fouling management, system reliability and remediation approaches can improve performance, reduce hazards and

strengthen environmental protection. Approaches that address specialist wastes, such as uranium containing materials, will further support proportionate long-term management and lifecycle assurance. The remediation of soil and groundwater contamination will further support proportionate long-term management, lifecycle assurance and delivery of future end states.

3.7.1 Optimised and/or innovative encapsulants or treatments

Challenge: How can we effectively immobilise radioactive wastes for storage and disposal using encapsulants or different treatment methods?

Strategic Themes: IWM, SDR

Optimised and/or innovative processes for the immobilisation and treatment of radioactive wastes can support risk reduction. This includes:

- Approaches that enable the effective immobilisation of problematic or hard-to-treat wastes, supporting proportionate management where existing encapsulation routes are limited.
- The development of new mixing technologies, encapsulant formulations or optimised deployment methods to achieve higher waste loadings.
- Uses of thermal technologies.
- Understanding the compatibility of new wastes with existing processes and how waste products evolve and interact with immobilisation matrices.
- The applicability of encapsulation techniques for in situ stabilisation of contaminated sub-surface structures to reduce the need for intrusive decommissioning.

Clearer evidence of disposability performance will support proportionate management of legacy wastes.

See Section [3.2.5](#) for more details on more sustainable encapsulants.

3.7.2 Efficient and selective treatment of liquid effluents

Challenge: How can we treat liquid effluents more effectively to remove radionuclides and priority chemicals?

Strategic Themes: IWM, SDR

As sites move to different phases of their lifecycle, effluent treatment strategies must also adapt to changing waste compositions and regulatory expectations. Research to advance the use of ion exchange media, optimised membrane processes (including reverse osmosis and nanofiltration), and innovative materials (such as nanomaterials and composites), and functionalised media can enhance treatment efficiency and selectivity. Improved environmental outcomes and reduced lifecycle impacts can be achieved through more efficient treatment systems.

3.7.3 Understanding and managing fouling in effluent systems

Challenge: What causes fouling (the build-up of solids, chemical precipitates or biological material) in active effluent systems, and how can we predict, prevent and remediate it?

- **Strategic Themes:** IWM, SDR

The development of approaches that prevent or minimise the extent of fouling within active effluent pipework and vessels will allow an earlier lifecycle management of fouling within systems. Advances in understanding fouling mechanisms will further support POCO and decommissioning efforts. Better prediction of fouling can allow earlier intervention and improved reliability. Development of new or modified techniques based on understanding of fouling would enable timely remediation of hazardous facilities. Adaptation of solutions from other industries is of interest.

3.7.4 Abatement techniques for aerial effluents

Challenge: How can abatement systems demonstrate proven and reliable capture efficiency across a range of operating conditions?

Strategic Themes: IWM, SDR

Understanding and improving the performance of filtration, scrubbing and other abatement systems for aerial effluents will support continued environmental protection. Research that examines how capture efficiency responds to changes in particle size distribution, air velocity and contaminant type will support the optimisation of plant operations and strengthen long-term compliance and resilience.

3.7.5 Treatment, reuse and disposal of uranium inventories

Challenge: What techniques, technologies and wasteform approaches can support the safe treatment, reuse or disposal of the NDA's uranium inventory?

Strategic Themes: NM

Developing improved treatment and conditioning approaches can reduce the hazard associated with stored uranium inventories. Research will consider options for reuse, including potential application as feed materials for future immobilisation products and treatment, and evaluate viable disposal routes. Work to develop suitable wasteforms and assess novel concepts (including the potential for co-disposal with other compatible waste streams where supported by safety assessments), will support proportionate long-term management. Stronger evidence on

the performance and long-term behaviour of treated uranium materials will support proportionate management, reuse opportunities and long-term disposal confidence.

3.7.6 Soil and groundwater remediation

Challenge: How can contaminated soil and groundwater be remediated safely and in a manner proportionate to the associated risks?

Strategic Themes: SDR

RD&I in practical remediation approaches remain important for safely managing legacy contamination. This may include materials that contain alpha-bearing materials, and contamination associated with historic near-surface disposal practices. Where excavation or removal is not appropriate, innovative chemical, physical and biotechnological methods to immobilise contaminants at source and limit plume migration may provide effective alternatives, but many advanced remediation technologies are still relatively immature for nuclear site deployment. Understanding how evolving environmental and climatic conditions may influence the long-term effectiveness of remediation approaches will further support sustainable management and site stewardship, leading to clearer pathways toward future site end states.

3.8 Spent fuel conditioning

Conditioning spent fuel for long-term management requires robust, evidence-based approaches that will support the safe transition from wet to dry storage, either as a contingency to wet storage, or in preparation for geological disposal. Improving understanding of fuel and cladding behaviour during these transitions, alongside the development and validation of drying, conditioning and monitoring technologies will underpin resilient dry storage solutions suited to the UK spent fuel inventory. Together, these advances will underpin long-term strategies, maintain flexibility in future management routes and strengthen assurance in disposal readiness.

3.8.1 Transition from wet to dry storage

Challenge: Which advanced techniques enable the safe, efficient and demonstrable transition from wet to dry storage of spent fuel?

Strategic Themes: SF

Continued development of technologies and techniques that enable safe and efficient drying and conditioning of spent fuel will support long-term dry storage and disposal strategies. This includes approaches applicable to Magnox and AGR fuels, alongside improved metrology and monitoring methods capable of detecting and quantifying residual moisture following drying. Further development of post-storage examination and validation techniques will strengthen

confidence in expert judgment and fuel evolution models that underpin assessments of conditioned fuel integrity, increasing assurance in storage and disposal plans.

3.8.2 Understanding fuel and cladding behaviour during drying

Challenge: How can we better understand and manage the corrosion and degradation mechanisms affecting fuel cladding during the drying and conditioning process?

Strategic Themes: SF

Improved understanding of the chemical and physical processes affecting fuel cladding during drying is required to manage the risks of corrosion, oxidation, cracking and sensitisation. Research will continue to focus on AGR fuel and consider both intact and failed fuel assemblies, combining laboratory experiments with modelling studies. Advances in this area will seek to define the range of environmental and process conditions in which cladding degradation is not feasible or highly unlikely, supporting confidence in the long-term stability of dried fuel and robustly underpinned long-term management decisions.

3.8.3 Options for long-term and contingency dry storage

Challenge: What are the optimal approaches for dry storage of AGR and other exotic spent fuels (e.g. fuels from research reactors), both as buffer storage and as long-term conditioning routes prior to disposal?

Strategic Themes: SF

Research into dry storage solutions will focus on developing technically and economically viable container designs, environmental control systems and monitoring approaches. These designs should ensure safety, retrievability from interim storage, and compliance with disposal requirements. Advances in this area will provide the evidence needed to optimise spent fuel storage strategies, reduce lifecycle cost and support future disposability needs. Developing contingency strategies that maintain resilience if wet storage becomes unavailable and remain compatible with geological disposal routes is also an important aspect of this work. Resilient and flexible solutions that accommodate future management scenarios and programme needs will strengthen long-term confidence in the viability and effectiveness of the current strategy.

3.9 Plutonium immobilisation

Immobilising the UK's plutonium inventory requires approaches that deliver robust, durable and demonstrably disposable wastefoms. Advances in candidate wastefom manufacturing methods, in wastefom and associated disposal concepts performance assessment, and studies of the future infrastructure required to support the immobilisation programme will help build the

evidence base needed for the effective long-term management of plutonium-bearing materials. There are two technologies for immobilisation being explored, Disposal MOX (DMOX) which creates ceramic pellets designed for disposal, and Hot Isostatic Pressing (HIP) where high pressures and temperatures are used to create a 'rock like' ceramic material.

3.9.1 Advancing disposal MOX (DMOX) manufacturing and qualification

Challenge: Which manufacturing, inspection and qualification approaches can deliver disposal MOX wastefoms with assured long-term performance and disposability?

Strategic Themes: NM

Research in manufacturing and inspection methods can improve quality assurance and reproducibility of disposal MOX wastefoms. This could be supported by novel fabrication and analytical techniques, small-scale inactive and active trials, and methods to validate wastefom integrity and long-term performance. Improved evidence of long-term performance will strengthen disposability confidence.

3.9.2 Technical maturity and performance of hot isostatic pressing (HIP) wastefoms

Challenge: How can we improve the technical maturity, manufacture and performance assessment of HIP wastefoms for plutonium immobilisation?

Strategic Themes: NM

Fundamental and applied research studies will seek to advance the technical maturity of HIP with respect to wastefom manufacturing, characterisation and performance over extended periods, focusing on key materials of interest (particularly zirconolites). The effort will seek to continue to progress the nuclearisation of the technique focusing on its use for plutonium, targeting increases in technology readiness level (TRL) sufficient to underpin the viability of this option at full scale and on relevant materials if required. Strengthening the evidence base will enable upcoming decisions on the immobilisation technology of choice for the UK plutonium inventory.

3.9.3 Facilities and infrastructure to enable future immobilisation

Challenge: What facilities and enabling capabilities are required to support the development, testing and qualification of future plutonium immobilisation technologies?

Strategic Themes: NM

A clearer understanding of the technical capability, capacity, requirements and constraints on a future plutonium immobilisation plant will be required. This will support future plant development and guide the identification and qualification of key technologies. This work is likely to include uranium-based active testing environments, assessment and validation of plant containment and characterisation systems, and their integration within the plant broader infrastructure. Flexibility and modularity may be important characteristics in supporting technology scale-up. Improved capability will support scalable development and strengthen confidence in long-term plutonium management approaches.

3.10 Underpinning the future end states of our sites

The understanding of how contaminants behave in the environment is essential to defining, protecting and enabling the future end states for our sites. Advances in modelling, environmental characterisation and impact assessment will further our ability to predict how contaminants migrate, degrade and influence surrounding ecosystems under current and future conditions.

3.10.1 Transport, degradation and fate of radioactive particles

Challenge: How can modelling and visualisation approaches improve our understanding of the transport, degradation and fate of radioactive particles in a range of environments?

Strategic Themes: SDR

Innovation in predictive modelling will advance our understanding of the fate and impact of radionuclides and radioactive particles in a range of environments (e.g. subsurface, marine), inclusive of their transport and degradation mechanisms. Advancing our understanding of the subsurface characteristics such as geology, hydrology, hydrogeology and chemistry of our sites will support innovation in this area. Improved modelling will support protection of people and the environment over long timescales.

3.10.2 The environmental impact of releases

Challenge: What are the environmental impacts of both radiological and non-radiological releases on and around our sites, and how do we assess and mitigate them?

Strategic Themes: SDR

The development of site models that describe contaminant sources, migration pathways and receptors in soils, groundwaters and surface waters will help better understand the environmental impacts of both radiological and non-radiological releases. Advances in our understanding of the chemical and biochemical processes that occur in a range of materials, such as buried and broken/crushed concrete that may result in the release of contaminants, will support prediction and management of releases within current and future climates. Improved evidence will strengthen environmental protection strategies and support resilience under future climate conditions.

3.10.3 Predicting long-term environmental changes

Challenge: How can modelling be used to support our understanding and prediction of long-term environmental changes?

Strategic Themes: SDR

Advances in modelling approaches will support the prediction of long-term environmental changes that may impact on our sites. Examples include:

- The impact of climate change (e.g. flash flooding, drought) on site evolution and the subsequent influence on the distribution and behaviour of contaminants in the environment, recognising the extended timeframes of the GDF mean impacts such as glaciation are also of relevance
- The mechanisms by which erosion may take place at coastal sites and the subsequent impacts of erosion processes.
- Improving the confidence associated with far-future impact predictions.

Improved modelling will support long-term planning, proportionate remediation and clearer decisions on future end states.

4 Further Information

NDA publish on our website [17] a wide variety of information relevant to research. This includes articles (e.g., *RrOBO: World-first demonstrates the future of nuclear clean-up is in safe hands* [18]), brochures [19] and technical reports (e.g., *Solid Radioactive Waste Characterisation Good Practice Guide* [20]). We also meet external stakeholders at a variety of events throughout the year (e.g., *NDA group celebrates progress and innovation in parliament* [21]). Key events particularly relevant to research include:

- Innovation Zone at the NDA Supply Chain Event [22]
- Annual PhD Bursary Seminar [22]
- Annual Nuclear Waste Decommissioning Research Forum Conference [23].

We attend and present at a variety of conferences, particularly those organised by learned societies and professional bodies.

Promotion of our publications and events is done through a variety of social media routes, links to which are on our website [17].

We can be contacted by email at research@nda.gov.uk.

5 References

1. [The NDA group Strategy Effective from March 2026 - GOV.UK](#)
2. [NDA's Grand Challenges for Technical Innovation: Interim Update 2025/26](#)
3. [NDA Groupwide Technology Baseline Review 2025/26](#)
4. [Nuclear Decommissioning Authority: Business Plan 2025 to 2028 - GOV.UK](#)
5. [The Nuclear Decommissioning Authority Mission Progress Report 2024 - GOV.UK](#)
6. [Grand Challenges for Technical Innovation - GOV.UK](#)
7. [NDA Areas of Research Interest - GOV.UK](#)
8. [Sellafield Ltd - Areas of Research Interest 2024 - GOV.UK](#)
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10. [NDA Innovation Strategy 2022](#)
11. [Clean Energy Superpower Mission areas of research interest - GOV.UK](#)
12. [Areas of research interest - GOV.UK](#)
13. [Writing and using Areas of Research Interest - GOV.UK](#)
14. [ARI Database | Search, browse or analyse Areas of Research Interest \(ARIs\) from UK governmental bodies.](#)
15. [Applying the waste hierarchy - UK Radioactive Waste & Materials Inventory](#)
16. [Managing Radioactive Substances and Nuclear Decommissioning: UK policy framework](#)
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20. *NDA Solid Radioactive Waste Characterisation Good Practice Guide (2022) GOV.UK.*
Available at: <https://www.gov.uk/government/publications/nda-solid-radioactive-waste-characterisation-good-practice-guide> (Accessed: 15 September 2023).
21. [NDA group celebrates progress and innovation in parliament - GOV.UK](#)
22. [NDA group holds 10th Supply Chain Event - GOV.UK](#)
23. [NDA group event for industry and next generation of nuclear experts - GOV.UK](#)

