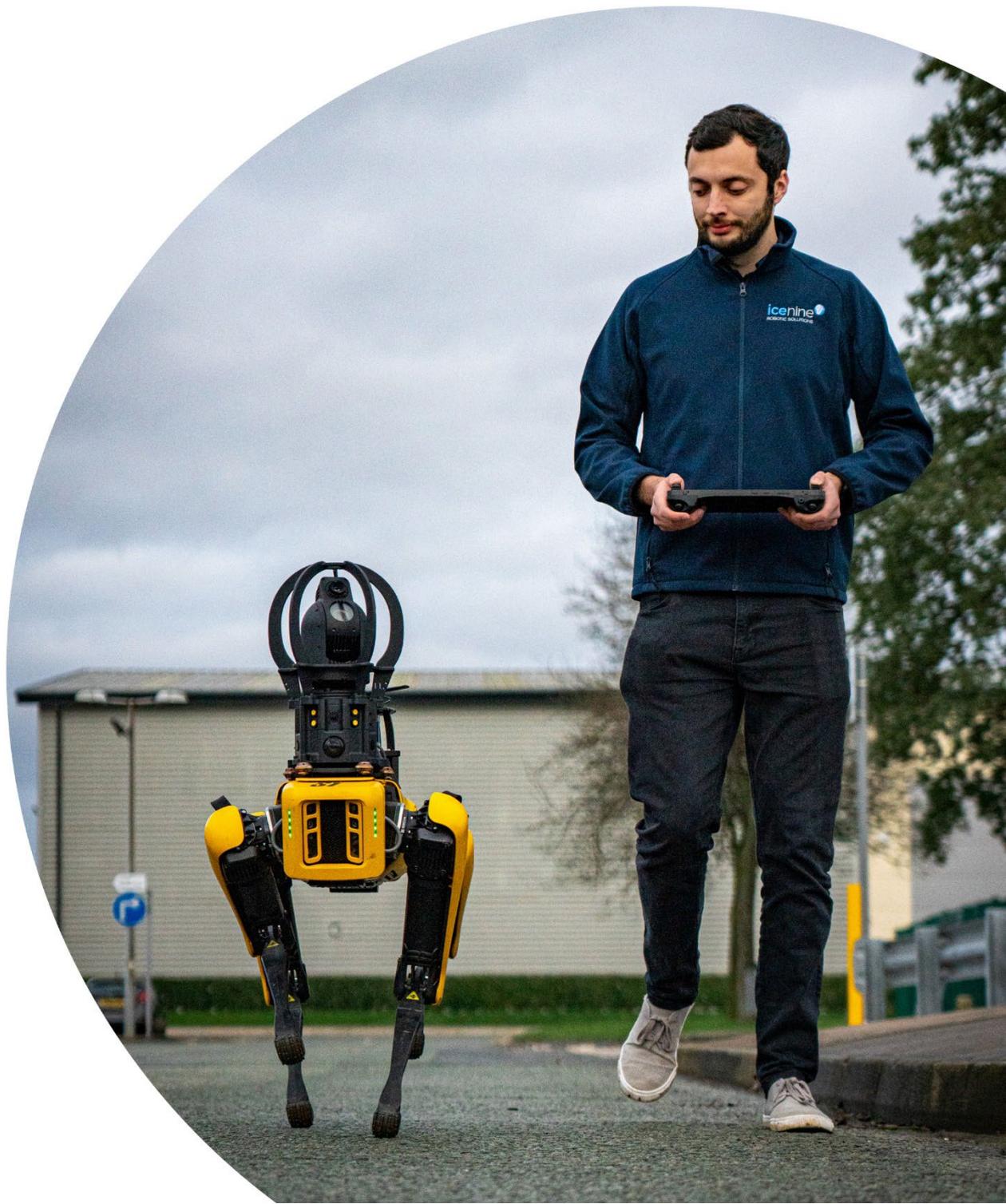




# The NDA's Grand Challenges for Technical Innovation

Interim update

2025/26



## Overview

Grand challenges are mission focussed, ambitious initiatives used to tackle complex, multi-faceted issues by driving momentum in targeted innovation, promoting collaboration and aligning innovation efforts. The NDA's Grand Challenges for Technical Innovation (GCfTI) were published in 2020, providing 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 this report provides an update on the learning and benefits realised to date. In the years since their publication, the NDA has undergone some significant changes. We now work as One NDA – combining Sellafield Ltd, Nuclear Restoration Services (NRS), Nuclear Waste Services (NWS) and Nuclear Transport Solutions (NTS), enhancing collaboration and efficiency. A significant shift to online working during the COVID pandemic provided challenges as well as opportunities, accelerating our move to more virtual ways of working. Externally, the publication of the UK's Modern Industrial Strategy [\[1\]](#) and Plan for Change [\[2\]](#) takes a mission-led approach to economic growth which centres around clear, long-term national missions and include a number of milestones. Despite significant changes since 2020, the GCfTI remain relevant and continue to drive meaningful progress in innovation at the NDA.

The Grand Challenges have already provided a myriad of benefits across the NDA, some of which are specific to innovation, some are broader organisational advantages. The GCfTI have increased momentum in our innovation, helping in the delivery of more than £300 million in savings from over 200 innovations since 2020, including several 'world-firsts'. Our investment in innovation has also helped to sustain a diverse and vibrant supply chain, enabling suppliers of all sizes to develop novel solutions and build capability across the nuclear sector.

The GCfTI have strengthened cross-group alignment of innovation, providing clarity on shared priorities and facilitating investment decisions. This has allowed for more extensive collaboration, both across government and internationally, including joint projects with defence run through the Defence and Security Accelerator (DASA) competitions, the LongOps robotics collaboration with the UK Atomic Energy Authority (UKAEA), Innovate UK and Tokyo Electric Power Company (TEPCO) in Japan and the Robotics and AI Collaboration (RAICo) with UKAEA, NDA, Sellafield, AWE and the University of Manchester.

The GCfTI are audacious, aspirational challenges that encourage creative approaches to innovation by providing a clear rationale for novel approaches. Their role in driving innovation has proven effective at the NDA to date with all interim aims achieved at a threshold level by 2025. Progress against the diverse challenges has not been uniform but provides confidence that we can progress to achieve the spirit of our GCfTI by 2030.

## The spirit of a ‘Grand Challenge’...

Grand Challenges should be bold, cross-cutting, disruptive and ambitious. Unlike incremental improvements, Grand Challenges set a clear direction of travel, stimulate collaboration, and encourage the development of many, ambitious solutions that would result in a step change in performance. This approach is recognised globally for its ability to catalyse new thinking, foster partnerships, and deliver benefits that extend beyond the original sector.

Unlike traditional organisational goals and targets, a Grand Challenge is audacious and provides benefits that stretch beyond the challenge itself, shifting behaviour, stimulating creativity and increasing the pace of change.



**Rather than a strategic goal, Grand Challenges act like a compass bearing – orientating everyone in the same direction, providing a focus to move toward and encouraging bold navigation over caution.**

Innovation is vital to help address the wide-ranging challenges across the NDA group. To help drive momentum, in 2020 we published our Grand Challenges for Technical Innovation [\[3\]](#) (GCfTI) to provide bold, cross cutting missions designed to accelerate progress on complex issues.

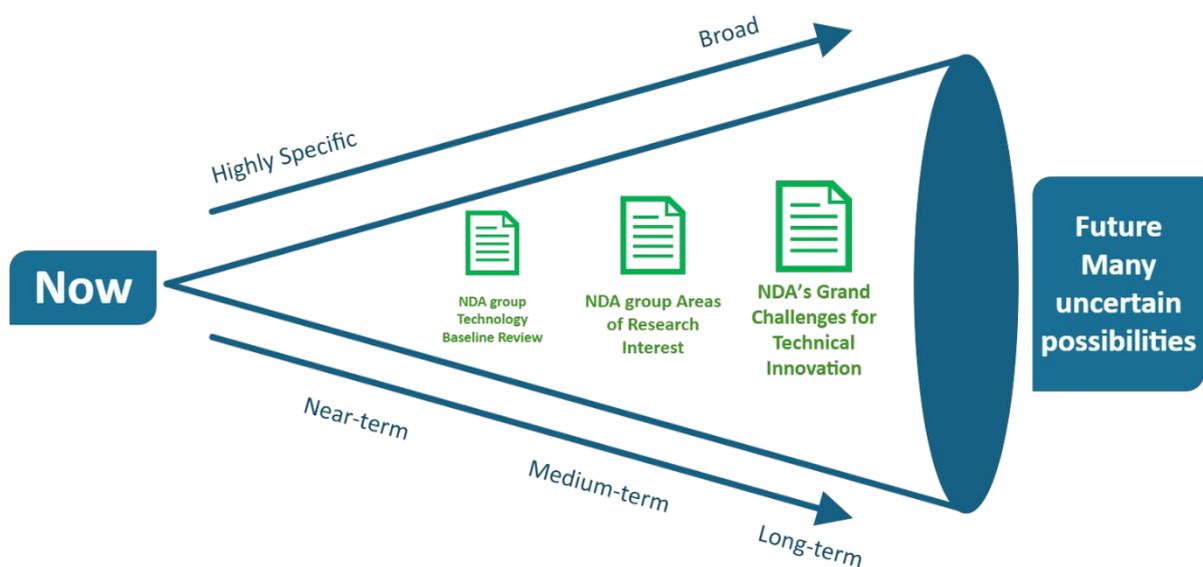
In the years since their publication, the NDA has undergone some significant changes. We now work as One NDA – combining Sellafield Ltd, Nuclear Restoration Services (NRS), Nuclear Waste Services (NWS) and Nuclear Transport Solutions (NTS), enhancing collaboration and efficiency. A culture of innovation at the NDA group thrives, with numerous world-first technology deployments on nuclear sites. The COVID lockdown took effect within weeks of the launch of the GCfTI, reducing our ability to communicate and effectively socialise them more widely across the group and with industry. Understandably, the pandemic delayed many projects and many priorities shifted, with resource effort being diverted onto initiatives which directly supported staff, enabled remote working and sustained jobs within the supply chain. The significant shift to virtual working, however, in other ways was a positive influence in relation to the GCfTI. Shifting to online ways of working rather than face to face engagements lowered cost and time barriers, enabling us to reach a much wider audience nationally and increasing SME participation. It also accelerated the modernisation of the NDA group’s underpinning digital infrastructure. Whilst there is still work to do to enable groupwide data sharing and digital delivery, the pandemic did demonstrate the value of being able to remotely access information and work in different ways.

## NDA Context

Our primary mission is to deliver safe, secure, sustainable and publicly acceptable solutions to the challenge of nuclear clean-up and waste management including the provision of disposal. The NDA group Strategy [4] sets the long-term direction for how the organisation fulfils its duties under the Energy Act (2004), providing clear context for oversight by the Department for Energy Security and Net Zero (DESNZ) and ensuring public accountability, with research, development and innovation (RD&I) acting as a critical driver of efficient and cost-effective mission delivery. Our Innovation Strategy [5] laid out a plan to transform delivery of our mission, making it safer, faster and obtain better value for money for the UK taxpayer. How we go about our work is very important to us and we must deliver results responsibly. Our commitment to creating environmental and social benefits builds on our long history of providing value for the UK and we want to ensure that our actions and decisions continue to have a lasting, positive impact.

The NDA's Grand Challenges for Technical Innovation are positioned alongside and complementary to the Technology Baseline Review [6] and Groupwide Areas of Research Interest [7], providing a triad of RD&I capability, requirements, interests and forward-looking ambition.

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. Looking beyond 2025, the NDA group is poised to build on our successes, with The NDA group Strategy providing a clear, ambitious and credible path forward. The Grand Challenges offer a complementary mechanism, providing shared aspirations that communicate a direction of travel against which innovation can align.



## The technical challenge themes

The NDA's Grand Challenges for Technical Innovation focus on four broad themes, each applicable across the NDA group, relevant to different market sectors, and with potential for wider societal impact:

- **Reducing Our Waste and Reshaping the Waste Hierarchy** [\[8\]](#) - finding new ways to drive value by proactively applying the waste hierarchy to the entirety of the NDA group inventory (active and non-active wastes), reducing consumption of resources, increasing recycling and re-use in order to reduce volumes sent for disposal. This could include new sensing techniques, multi-mode logistics, different treatment methods and optimising sorting and packaging approaches (remote sorting and smart packaging).
- **Intelligent Infrastructure** - using autonomous technology to monitor and manage assets and buildings efficiently. This could include new construction approaches (materials, modularisation, off-site build), smart stores and packages, and improving reliability and availability through the adoption of enhanced technologies which enable more proactive management practices and predictive, improved performance.
- **Moving Humans Away from Harm** - reducing the need for people to enter hazardous environments (including radioactive, working at height, asbestos) by making more use of autonomous systems, sensors and robotics. Where entry is required, making better use of enhanced training environments, wearable technologies and augmented reality.
- **Digital Delivery** - adopting modern technology for capturing, assuring and using data efficiently, to improve planning, immersive training and to aid decision-making, making more use of machine learning and artificial intelligence to enhance assurance or to help simplify data intensive processes.

## Our aspirations for technical innovation

The aims and aspirations were designed to inform NDA group-wide innovation programmes, building on existing R&D and providing a catalyst for more integrated systems and services, while also influencing innovation activity beyond the NDA. While the challenges are 'solution agnostic', it is expected that key emerging technologies - such digital technologies, robotics and AI - will play a significant role in achieving these goals.

Theme	Interim aims (2025)	Our 2030 Aspirations
Reducing our waste and reshaping the waste hierarchy (NDA Grand Challenge 1)	70% of all initial characterisation will be undertaken in-situ with results available within 24 hours	50% of waste, produced from decommissioning and clean-up, being recycled  Over 70% reduction in the generation of 'secondary wastes' - particularly those associated with decontamination
Intelligent infrastructure (NDA Grand Challenge 2)	All external monitoring of buildings should be carried out remotely	All new buildings to be self-monitoring and energy neutral by 2030 with a 50% lifetime cost reduction
Moving humans away from harm (NDA Grand Challenge 3)	Remote decommissioning of gloveboxes	A 50% reduction in decommissioning activities carried out by humans in hazardous environments
Digital delivery (NDA Grand Challenge 4)	Accurate and up to date 3D virtual models (such as digital twins) exist for all key NDA sites	All data captured at source which is then used to drive decisions, planning and training

In the same spirit as the Grand Challenges themselves, these bold, aspirational statements aim to accelerate progress in key technology areas. Additionally, they provide a point at which we can reflect on progress to help us understand what is working well and whether any unforeseen challenges have emerged.

### Benefits and Shared Learning

The Grand Challenges help to inform R&D investment decisions, identifying where technology can have the greatest strategic impact, ensuring that funding is directed accordingly and helping communicate these priorities to influence external investment decisions. By aligning innovation efforts with long-term goals, they help maximise value for money and accelerate progress against NDA's mission. This integration also ensures that technical progress is not siloed but contributes to broader organisational objectives.



**The NDA Group has made over £300 million in savings from 200+ innovations between 2021 and 2024.**

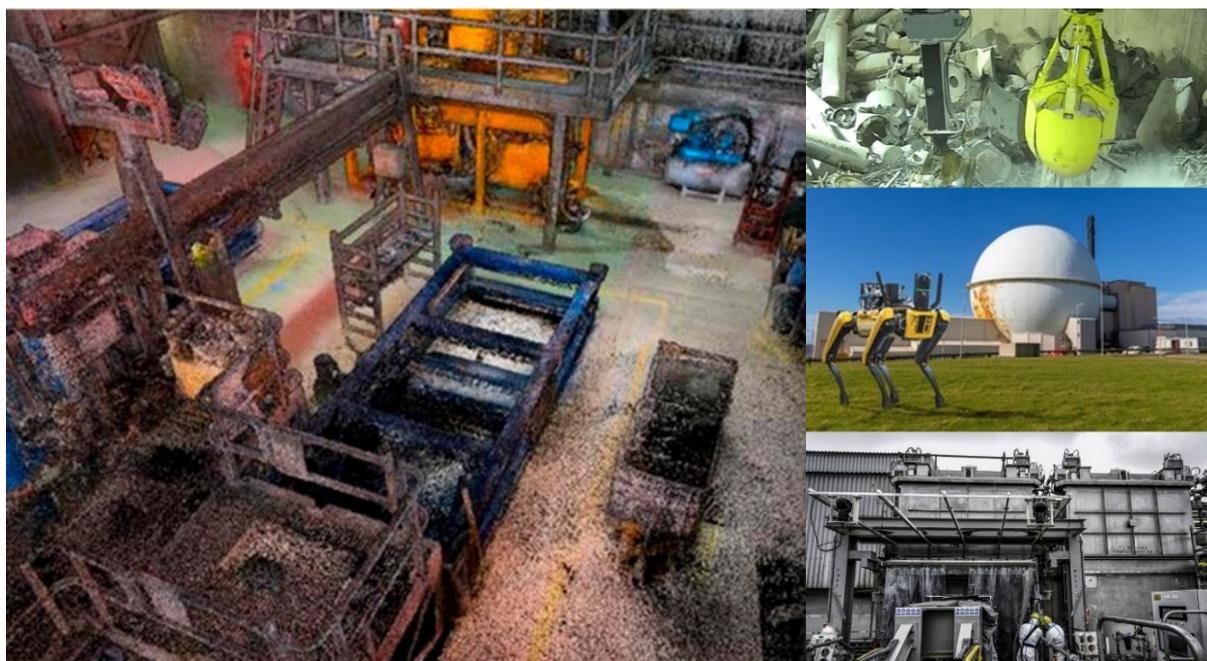
The NDA group uses the Grand Challenges to categorise and communicate the value of their innovation activities – for example Sellafield (SL) has aligned the innovations in the Annual R&D Review to the Grand Challenges. This structured approach helps stakeholders understand how specific projects contribute to overarching goals, enhancing transparency and engagement.

One of the most powerful benefits of the Grand Challenges is the facilitation of shared learning. Sites can build on each other's successes and avoid repeating past mistakes. Equally, when innovations fall short, these lessons are openly shared, fostering a culture of continuous improvement.

The Grand Challenges are helping to shift mindsets and working practices across the group, encouraging cross-disciplinary collaboration and forward-thinking approaches, they are driving a more agile, innovative, and risk-aware ways of working. By providing a common set of innovation goals, the Grand Challenges cultivate collaboration and align efforts that otherwise might have been siloed. Our innovation projects are often jointly funded with other public sector partners, such as Innovate UK, UKAEA and DASA (now UK Defence Innovation), helping to maximise the level of funding available to deliver benefits to our shared challenges. The Grand Challenges facilitate such collaboration, making it easier to identify shared goals and common challenge areas. Beyond the NDA group, our investment in innovation has provided funding for the development of technical solutions sustaining a more diverse and vibrant supply chain.



**The NDA Group spent £2.27bn with around 5,000 UK suppliers, 38% of which are SMEs indirectly supporting 40,000 jobs and bringing jobs and investment back to industrial heartlands.**



*Pictures demonstrate some of the technology innovations being deployed at the NDA group.*

## Grand Challenge Themed Innovations

Over the past five years, the NDA group has introduced a range of technical innovations – from cutting-edge robotics and remote handling to advanced digital tools and novel engineering techniques – to tackle the unique challenges of nuclear decommissioning. The sections below provide a selection of examples of initiatives and RD&I projects that support the Grand Challenges, noting this is not a definitive or exhaustive list and that some projects listed do align to multiple different challenge themes. We cannot capture all of our RD&I in this report, but the aim is to highlight the range of activity and wider players involved.

### Reducing our waste and reshaping the waste hierarchy

The NDA group has delivered some first of a kind and new-to-nuclear innovations that directly support our ambition to reduce our waste and reshape the waste hierarchy. An ongoing project with the University of Strathclyde is exploring pioneering methods to detect and identify the presence of asbestos using non-contact spectral imaging techniques. Alongside this, advanced robotics and automated systems are enabling safer, more precise retrievals from legacy facilities, minimising secondary waste production and improving opportunities for repurposing or recycling. Some key innovations contributing to the aims and aspirations of this challenge are listed here, with more a more in-depth overview in the timeline on the following page.

2025 Aim - 70% of all initial characterisation will be undertaken in-situ with results available within 24 hours.

- Radiation and 3D mapping – CARMA, an autonomous robot platform has been used to characterise and monitor large areas of floor space for fixed or migrating contamination [\[9\]](#).
- Remote hydrogen detection - Hydrogen generation rate is a good way to determine how waste is evolving. A system using Raman spectroscopy capable of detecting low concentrations of hydrogen at a distance has been successfully developed and trialled [\[9\]](#).
- Auto Sort and Segregate - Initiated through a competition call for an autonomous method of sorting and segregating waste, a range of technology developments were showcased in 2023. The next phase of the project will see demonstrations of a refined 'auto-SAS' product [\[10\]](#).

2030 Aspirations - 50% of waste, produced from decommissioning and clean-up, being recycled. Over 70% reduction in the generation of 'secondary wastes' - particularly those associated with decontamination.

- Sustainable cement – Testing of a range of alternative cement mixtures for their ability to encapsulate waste. One geopolymers showed capacity to double the amount of waste that could be held in a container, potentially offering a route to reduce secondary waste through lower encapsulant requirement [\[11\]](#).
- Sizewell A concrete reused at Sizewell C – More than 15,000 tonnes of concrete from the demolition of a turbine hall will be recycled and used in construction for sub-bases at Sizewell C [\[12\]](#).

# The NDA Group

## Innovations

### Reducing our waste and reshaping the waste hierarchy

In 2025, in another world first, Spot was deployed into an active waste store to conduct a fully autonomous inspection - the characterisation data collected confirmed an area was safe to enter.

In 2023, a world-first was achieved by mounting a LIDAR laser scanner on Spot and deploying it in a high-radiation area that was unsafe for people.

**UK first plutonium processing milestone**  
NDA group delivered a UK-first nuclear safety milestone, by safely processing a can of plutonium residue into a stable waste form for the very first time.

**2025**  
**Hyperspectral imaging of asbestos**  
Hyperspectral imaging device capable of detecting asbestos has developed and demonstrated.

**2025**  
**Gecko robot**  
The wall-crawling Gecko robots capable of climbing metallic structures to deploy inspection and characterisation tools. Successfully trialled at the Oldbury site, it remotely scanned inactive CO<sub>2</sub> tanks.



**2024**

**Explosive demolition of turbine hall plinths**  
A bold 14-second controlled explosion replaced traditional turbine hall demolition, simplifying material separation and providing efficient, sustainable decommissioning.



**Concrete scabbling**  
Demonstration of concrete scabbling system capable of remove contaminated surface layers from concrete without releasing any dust.



**Sustainable cement**  
After testing a range of cements for their ability to encapsulate waste, one geopolymers showed potential to double the amount of waste that could be held in a container.

**AI sludge rheology**  
Demonstration of AI predicting how sludge from legacy silos will behave over time. This will allow data-driven assessment for efficient disposal.

**Automated Stores**  
Through collaboration with the NNL, the SNM innovation team was able to design and demonstrate an effective automated system tailored to address the identified challenges in the SNM store.

**2023**  
**Skip size reduction facility**  
Building on experience using automated laser cutters, the SSRF automatically cuts and repacks legacy Magnox skips. Size reduction and packing of skips enables the volume of waste to be reduced by 2/3

**Gamma Optical Video Imaging (GOVI)**  
Procured in 2023, GOVI provides real time gamma imaging, the handheld camera can identify areas of focus during manual cleaning (for example, in congested gloveboxes)

**Auto Sort and Segregate**  
Initiated through a competition call for an autonomous method of sorting and segregating waste, a range of technology developments were showcased in 2023. The next phase of the project will see demonstrations of a refined 'auto-SAS' product.



**Snake ROV for radiometric characterisation**  
Fitted with a lightweight radiometric detector, the ROV was able to survey hard-to-reach areas, enabling visual and dose-rate characterisation in high-radiation zones.



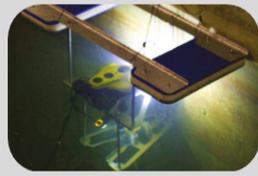
**Raman spectroscopy through glovebox windows**  
An initial proof of concept undertaken in a lab demonstrated the possibility of using Raman spectroscopy to perform chemical identification through a glovebox window

**2022**  
**CARMA 2 Radiation and 3D Mapping**  
Autonomous robot platform successfully demonstrated its ability to characterise and monitor large areas of floor space for fixed or migrating contamination.



**Remote Hydrogen Detection**  
Hydrogen generation rate is a good way to determine how waste is evolving. A system using Raman spectroscopy capable of detecting low concentrations of hydrogen at a distance was successfully developed and trialled in 2022.

**In-pond ROV gamma spectrometer**  
A modified ROV with in-pond monitoring station developed, built and actively tested.



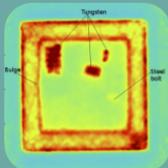
**2021**  
**Robotic Quadroped Deployments**  
Since 2021 teams across the NDA have been equipping quadroped robots (Spot) with various sensor payloads to perform inspections inside buildings.

**2020**  
**Prototype Smart Can**  
Smart Sensors that attach to SNM cans to monitor their pressure and temperature for decades.



**Thermal Treatment of Waste**  
The Higher Activity Waste Thermal Treatment (HAWTT) programme was established in 2021 with the intent to enable decision making and unlocking an NDA baseline change.

**2020**  
**Muon Tomography of Waste Packages**  
Using cosmic-ray muons to non-invasively image the contents of nuclear waste containers. This tool has been actively used to characterise and monitor nuclear waste packages.



**2020**

**Grand Challenges for Technical Innovation Published**

## Intelligent Infrastructure

The NDA group is advancing the intelligent infrastructure challenge via a suite of innovations that combine autonomous technologies, data driven decision making and new construction and monitoring approaches. An example of such an innovation is NDA's collaboration with the Defence and Security Accelerator (now UK Defence Innovation) to develop a security system for remote monitoring of sensitive sites which is now in its second phase of development. In line with the challenge's interim aim, remote building surveys – via ROV and UAV – are now conducted as standard unless there is clear rationale for a manual survey. Some key innovations contributing to the aims and aspirations of this challenge are listed here, with more a more in-depth overview in the timeline on the following page.

### 2025 Aim - All external monitoring of buildings should be carried out remotely

- Sellafield was the first in the world to mount a LiDAR scanner on an ROV robot for use in high-radiation areas [\[13\]](#) and the UAV team won a Nuclear Manufacturing Award recognising their work on remote inspections [\[14\]](#).
- AI for defect recognition - NRS is trialling AI to improve inspections of ageing cladding and roofing, critical components protecting infrastructure across the estate.
- Remote building surveys are now conducted as standard where this method is the most appropriate.

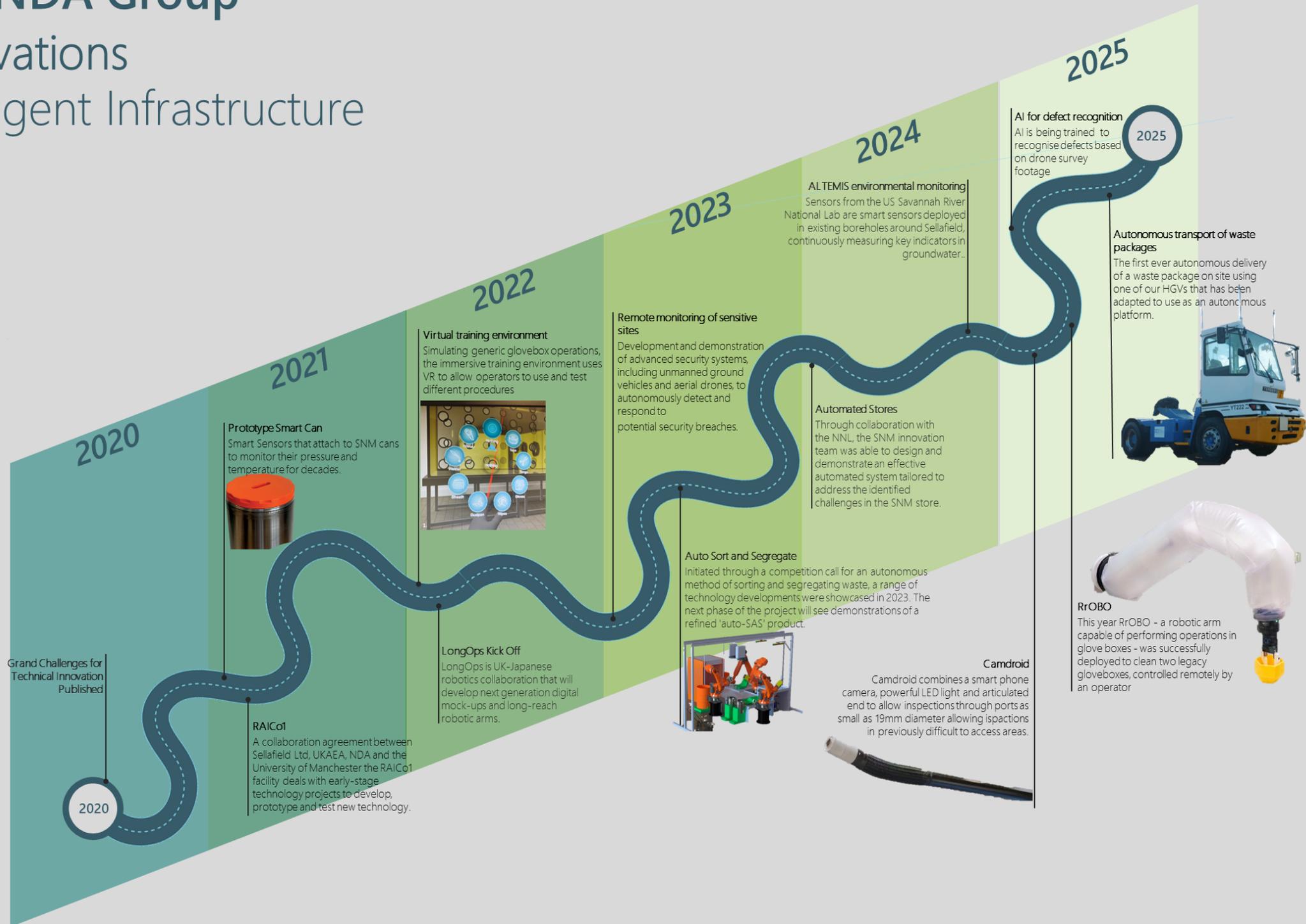
### 2030 Aspiration - All new buildings to be self-monitoring and energy neutral by 2030 with a 50% lifetime cost reduction

- Our scope 1 and scope 2 carbon emissions were reduced by 34% since 2019/20 [\[15\]](#).
- Remote Monitoring of Sensitive Sites - the RMSS project has led to the development and demonstration of advanced security systems, including unmanned ground vehicles and aerial drones, to autonomously detect and respond to potential security breaches [\[16\]](#).
- A major step toward self-monitoring waste packaging was achieved as smart sensors successfully streamed live temperature and pressure data from inside Special Nuclear Material containers. Evolving over seven years from radiation-tolerant prototypes to fully embedded wireless sensors, the latest trials showed continuous in-situ monitoring is now possible [\[17\]](#).
- Construction of a green energy hub is planned at Chapelcross site. The net-zero–focused development designed to bring new clean-energy industries and high-value jobs to the region [\[18\]](#).

# The NDA Group

## Innovations

### Intelligent Infrastructure



## Moving humans away from harm

The NDA's commitment to keep humans out of harm's way has spurred development of remote technologies. Through the Robotics and AI Collaboration (RAICo) and other projects, quadruped robots like SPOT, tethered snake-arm robots, and submersible ROVs have been deployed for inspections, mapping, and even intervention inside high-radiation areas. Advanced robotics, drones and remote-handling technologies are becoming commonplace on NDA sites. These technologies dramatically reduce risk to personnel and are increasingly moving from pilot to routine use. Some key innovations contributing to the aims and aspirations of this challenge are listed here, with more a more in-depth overview in the timeline on the following page.

### 2025 Aim – Remote decommissioning of gloveboxes

- Risk reduction of glovebox operations (RrOBO) - A robotic arm capable of performing operations in glove boxes - was successfully deployed to clean two legacy gloveboxes, controlled remotely by an operator.
- AmCam - A handheld radiometric inspection device that produces a live video and real-time count rate from a gamma detector, used routinely to aid glovebox decontamination [\[9\]](#).

### 2030 Aspiration - A 50% reduction in decommissioning activities carried out by humans in hazardous environments

- The first ever autonomous delivery of a waste package on site using one of our HGVs that has been adapted to use as an autonomous platform.
- Robotics and AI Collaboration Forum – A collaboration between the NDA, UK Atomic Energy Authority, Sellafield, the University of Mancher and AWE which develops remotely operated solutions for decommissioning [\[19\]](#).
- Camdroid – a compact inspection camera with an articulating end allowing inspections of previously inaccessible infrastructure has been demonstrated. The device delivers high-resolution images and video through a 19mm port in concrete walls up to a metre thick [\[20\]](#)
- Integration of quadruped robots (Spot) for novel tasks – Spot has been increasingly deployed across the NDA to undertake tasks that require human dexterity, such as physically operating an electrical isolation switch, removing the need for personnel to enter high-risk areas [\[21\]](#).
- Autonomous sort and segregation (AutoSaS) – Scheduled for deployment at Oldbury in 2028 and developed across the NDA group, AutoSaS showcases an integrated solution capable of autonomously sorting and segregating radioactive materials - traditionally a manual and labour-intensive process.

# The NDA Group

## Innovations

### Moving Humans Away From Harm

In 2025, in another world first, Spot was deployed into an active waste store to conduct a fully autonomous inspection - the characterisation data collected confirmed an area was safe to enter.

In 2023, a world-first was achieved by mounting a LiDAR laser scanner on Spot and deploying it in a high-radiation area that was unsafe for people.



2025

2025

2024

2023

2022

2021

2020

**Robotic Quadroped Deployments**  
Since 2021 teams across the NDA have been equipping quadruped robots (Spot) with various sensor payloads to perform inspections inside buildings.

**Skip size reduction facility**  
Building on experience using automated laser cutters, the SSRF automatically cuts and repacks legacy Magnox skips. Size reduction and packing of skips enables the volume of waste to be reduced by 2/3

**Explosive demolition of turbine hall plinths**  
A bold 14-second controlled explosion replaced traditional turbine hall demolition, simplifying material separation and providing efficient, sustainable decommissioning.



**Autonomous transport of waste packages**  
The first ever autonomous delivery of a waste package on site using one of our HGVs that has been adapted to use as an autonomous platform.



**Lyra crawling robot**  
The robot has been used to inspect ventilation ducts and feedback radiological information..



**RrOBO**  
This year RrOBO - a robotic arm capable of performing operations in glove boxes - was successfully deployed to clean two legacy gloveboxes, controlled remotely by an operator

**Gamma Optical Video Imaging (GOVI)**  
Procured in 2023, GOVI provides real time gamma imaging, the handheld camera can identify areas of focus during manual cleaning (for example, in congested gloveboxes)

**Raman spectroscopy through glovebox windows**  
An initial proof of concept undertaken in a lab demonstrated the possibility of using Raman spectroscopy to perform chemical identification through a glovebox window

**Auto Sort and Segregate**  
Initiated through a competition call for an autonomous method of sorting and segregating waste, a range of technology developments were showcased in 2023. The next phase of the project will see demonstrations of a refined 'auto-SAS' product.



**FIRMArm remote access tool**  
The tool uses a camera and radiometric probe and can extend through inspection ports for remote access. The active demonstration involved deployment within a tank to provide characterisation data.



**CARMA 2 Radiation and 3D Mapping**  
Autonomous robot platform successfully demonstrated its ability to characterise and monitor large areas of floor space for fixed or migrating contamination.



**Remote Hydrogen Detection**  
Hydrogen generation rate is a good way to determine how waste is evolving. A system using Raman spectroscopy capable of detecting low concentrations of hydrogen at a distance was successfully developed and trialed in 2022.

**Lyra Crawling Robot**  
The robot has been used to inspect ventilation ducts and feedback radiological information.



**LongOps Kick Off**  
LongOps is a UK-Japanese robotics collaboration that will develop next generation digital mock-ups and long-reach robotic arms.

Grand Challenges for Technical Innovation Published

2020

## Digital delivery

The early years of the Grand Challenges saw the NDA rapidly move to remote working, accelerating the modernisation of the group's digital infrastructure. The move opened up new ways of working and provided opportunities to collaborate in a more modern, more digital way. Since then, the NDA has published a Group Digital Strategy in 2022 as well as Sellafield's AI strategy in 2023 and in 2024 the Group Cyberspace Collaboration Centre was opened with a view to further accelerate deployment of innovative digital tools. Across the NDA digital innovations, from virtual training environments to a series of internally developed large language models (LLMs), trained on NDA data has added to our adoption of digital technologies, allowing intelligent collection and use of data. Some key innovations contributing to the aims and aspirations of this challenge are listed here, with more a more in-depth overview in the timeline on the following page.

2025 Aim - Accurate and up to date 3D virtual models (such as digital twins) exist for all key NDA sites

- Lidar scanning has been widely used to generate 3D models of key NDA structures. For example, NRS Dounreay use the Emesent Hovermap ST-X LiDAR scanner for non-intrusive 3D site surveys. The same system is used for coastal erosion monitoring, steam line design, and BIM integration
- Building information modelling (BIM) has been combined with a site digital twin to generate a federated 3D model of the low level waste repository.
- Demonstration of micro-UAV technology represents a step toward accessing and inspecting legacy nuclear infrastructure through restricted access points. The micro-UAVs were able to operate beyond visual line of sight in a fully enclosed, cluttered, GPS denied environment with no light [22].
- Trawsfynydd is pioneering digital modelling, waste management, and laser-cutting innovations, using BIM, reality-capture tools, and robotics to improve data accuracy and reduce human exposure in high-hazard areas.

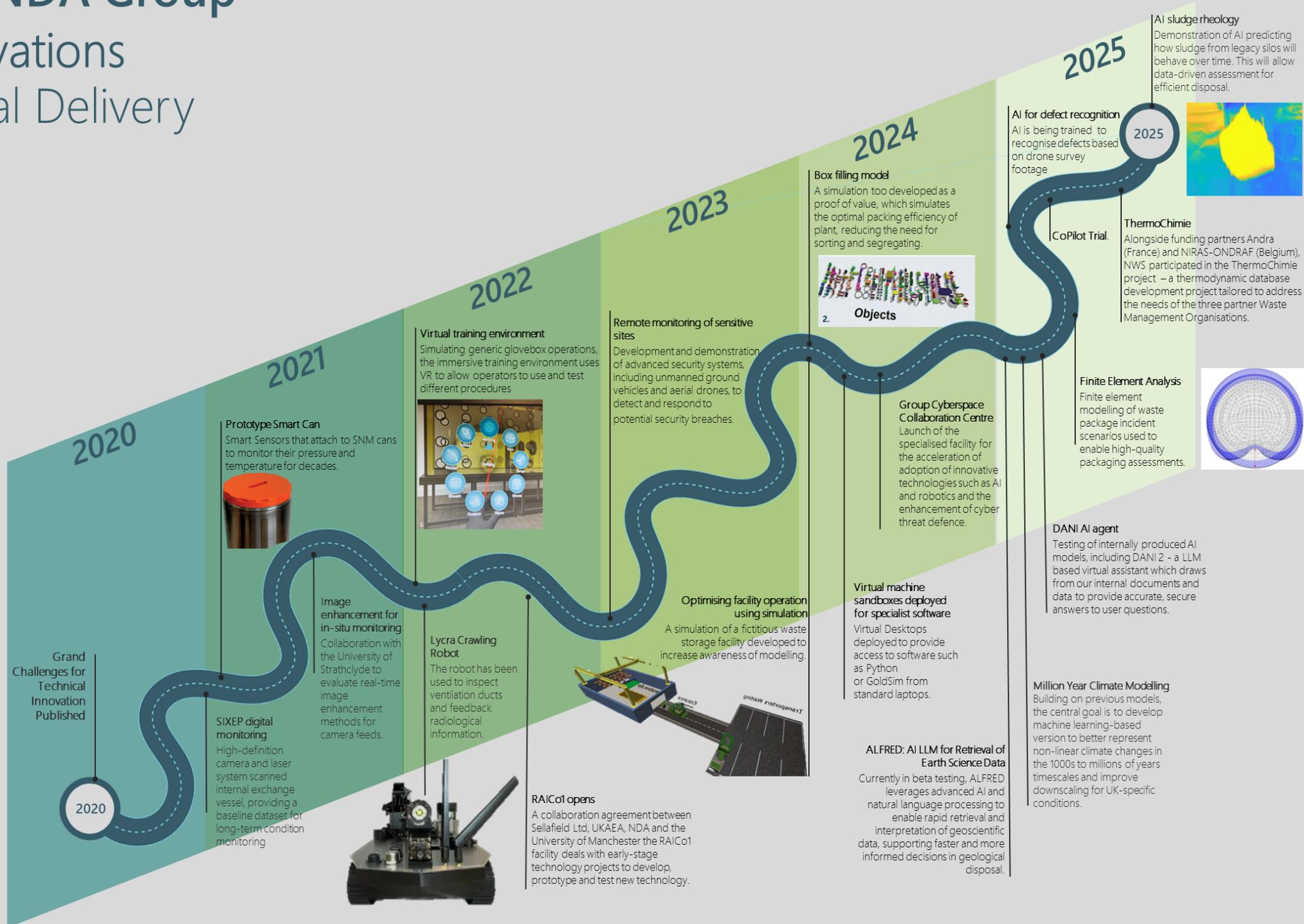
2030 Aspiration - All data captured at source which is then used to drive decisions, planning and training

- Virtual training environment – We have deployed several VR training tools, including simulating generic glovebox operations for immersive training, allowing operators to use and test different procedures [9].
- The Shaft and Silo project at NRS Dounreay adopted BIM to create a digital twin and single source of truth for a complex, multi-supplier programme, enabling clashes, sequencing and changes to be tested virtually before construction and supporting data driven decision making.

# The NDA Group

## Innovations

### Digital Delivery

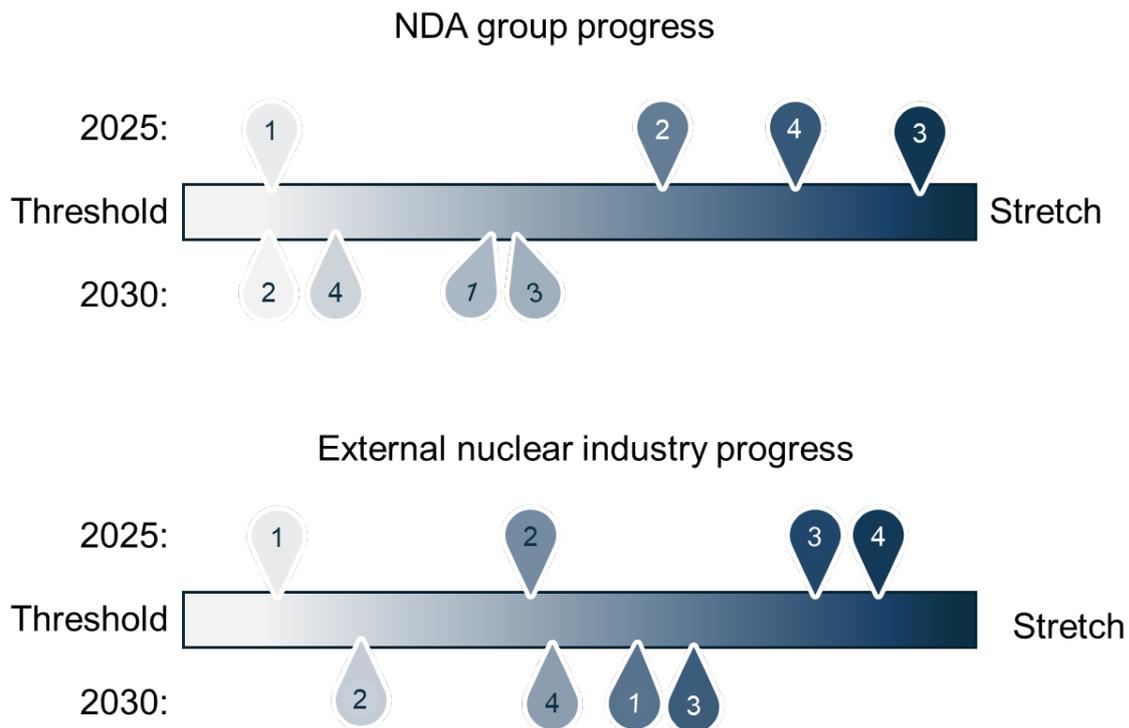


## Today's view

An internal assessment of our progress toward the Grand Challenges was conducted in 2025 to help us understand where we currently sit. This focused specifically on the 2025 aims and 2030 aspirations laid out in the Grand Challenges. Qualitatively scaled from threshold – where a small amount of progress has been made – through to stretch – where our grand challenge has been completed.

The internal highlighted several important lessons for the future. A consistent piece of feedback from stakeholders was in recognising the aims and aspirations laid out in the GCfTI as intentionally ambitious to the point of audacity, not because we have underperformed if they are not met, but because their purpose was to jump start momentum in those technology areas and create space for novel approaches. Feedback also indicated that using numerical examples - such as “70% of all initial characterisation will be undertaken in-situ with results available within 24 hours” – can be misinterpreted as a formal target. Participants also noted that some wording makes certain aims appear unachievable or overly absolute. For example, the aim of conducting *all* external building monitoring remotely was considered unrealistic – rather remote monitoring is conducted as default, unless there is clear rationale for manual survey. Focusing solely on innovations that directly meet the GCfTI aims also risks overshadowing the substantial achievements that contribute more broadly to the Grand Challenges. To illustrate this wider landscape, road-map infographics have been included.

To calibrate our progress toward the Grand Challenges it is important to understand technological innovation in the wider nuclear industry - to identify whether we are ahead of or behind the curve compared to other regulated industries for each challenge. The external nuclear industry is not working toward the same Grand Challenges as the NDA. However, a range of technologies relevant to the aims and aspirations of the GCfTI has been deployed across the sector. These technologies - typically developed to address specific needs or requirements - represent examples published solutions currently deployed in the sector. Together, they have been used to assess progress within the wider nuclear industry.



Above threshold progress has been made toward all the aims and aspirations laid out in the GCFTI. Several major innovations have led to strong progress across most of the 2025 aims, with progress approaching stretch status for three of the four challenges. There is also clear momentum toward the 2030 aspirations, with good progress being recorded providing confidence that we can achieve the overall intent our Grand Challenges by 2030.

Grand Challenge 1 – Reshaping our waste and reshaping the waste hierarchy aimed for 70% of characterisation done in situ with results available in 24 hours. Although this challenge had the largest number of associated innovations, progress toward this aim was assessed as slightly above threshold for the 2025 ambition, with marginally stronger progress toward the 2030 aspiration. Innovations such as spectral imaging for asbestos detection to muon tomography and several “world first” deployments – including a quadruped robot working in an active waste store – have contributed to this challenge. However, stakeholder feedback suggested the technology required to fully meet the aim is not yet sufficiently mature. This is consistent with the progress noted in the wider nuclear industry.

Greater progress has been made toward the aims for Challenges 2 (intelligent infrastructure) and 4 (digital delivery) with progress leaning closer to stretch than threshold status. Thanks to the deployment of remotely controlled RrOBO within legacy gloveboxes, the aim of Challenge 3 – remote decommissioning of gloveboxes- was near to stretch status, with plans to now embed the technology into business-as-usual operations.

Progress toward the 2030 aspirations is generally at a good level, although Grand Challenge 2 – Intelligent Infrastructure – is closest to threshold, with stakeholder discussions indicating that the limited number of buildings we construct prioritise safety and functionality, limiting the scope for this aspiration to be met yet. In addition, data security and data infrastructure limitations have slowed our progress somewhat. Nevertheless, significant work is underway in smart monitoring and carbon management. For example, the planned shaft and silo building at Dounreay has been designed using a federated 3D model which includes a Building Information Model and PAS 2080 lifecycle carbon management capability.

### **What's next for the Grand Challenges**

The Grand Challenges have accelerated innovation across the NDA, delivering over £300 million in savings from more than 200 innovations since 2020 and supporting a diverse, capable supply chain. They have strengthened cross-group alignment, clarified shared priorities, and enabled major collaborations across government and internationally. While some challenges have progressed faster than others, the GCFTI continue to drive bold, creative innovation, and refining our approach will be essential as we work toward our 2030 goals. As we continue to make progress, it is important to recognise that some of our original Grand Challenges may no longer be as “grand” as they once were. In several areas, major innovation advances mean that the core challenge has been substantially addressed. Our horizon-scanning and research portfolio will keep evolving to support our 2030 ambitions, but we must now also look beyond that horizon and consider what the next generation of Grand Challenges should be. This presents an opportunity to refresh the framework, ensuring it continues to stretch ambition and reflect emerging priorities.

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