NDA PhD Bursary Call 2024:

Developing and Maintaining Skills and Innovation Relevant to Nuclear Decommissioning and Clean-up

The NDA is requesting applications to its bursary call, to support the NDA mission to deliver safe, sustainable and publicly acceptable solutions to the challenge of decommissioning and clean-up of the UK's civil nuclear legacy. The NDA's goals from the call are as follows:

- Maintain and develop the key skills that will be required to help us carry out the mission over the coming decades
- Provide fundamental understanding of technologies and processes across the NDA estate
- Develop early-stage technologies (TRL 1 – 3)
- Encourage two-way knowledge transfer between the academic and industrial communities working on nuclear decommissioning

What is not covered under the call is R&D focused on site-specific challenges such as improving the efficiency of an existing plant or process or on training resource in a specific capability[1]. Those research areas are the responsibility of the individual subsidiaries and SLCs.

Applicants are advised to seek advice on the structure and content of their proposal prior to submission. Contact details can be found at the end of this document.

The call is open to UK academic institutions for projects that will lead to the award of a PhD. This year, up to £750,000 is available from the NDA PhD bursary to support projects that will lead to the award of a PhD. Universities and Research Institutes are invited to make proposals up to a value of £150,000 per project under the thematic areas outlined below. NDA recognise that increases in the cost of living have impacted postgraduate researchers. In line with the recent UKRI announcement, NDA expect students funded through the NDA PhD bursary call to receive a stipend that is at least equivalent to those paid by UKRI. Note that UKRI have removed any specific guidance relevant to a London weighting for 2023/4. NDA will not object to a stipend increase for the purposes of ensuring the stipend is competitive with your departmental guidance.

[1] Please contact mark.bankhead@uknnl.com in the first instance to discuss your project idea if you are unsure if it is applicable.

A) Characterisation

The industrial need can be summarised as follows:

- Remote/rapid building, plant, and contaminated land surveillance
- Remote/rapid sampling techniques for hazardous environments
- Improved and/or new techniques for in-situ analysis of contaminated land, buildings, effluents and waste packages

(A.1) (Rapid) in-situ analysis

Improved techniques for the surveillance and characterisation of plant, structures, waste, land and effluents for radiological and chemical contamination. Remote (field sensing) for contaminated land, buildings, effluents and waste/ residue packages. Improved detectors, such as solid-state alpha cameras for more rapid analysis/more flexible deployment/improved information content.

(A.2) Rapid and automated analytical techniques

More rapid analysis methodology to support automation, especially in labour-intensive areas of sample preparation and radionuclide separations. This is to improve analysis cost, reduce liquid waste arisings, improve turnaround time and improve supply-chain capacity. A key focus area is improved analysis/assay capabilities for alpha and beta radionuclides.

For example:

- Developments with ICPMS for elemental/radionuclide analysis [either on the front end i.e. (IC-ICPMS) or other chromatographic/resin pre-treatment, or measurement e.g. ICPMS CRIS developments with protocols e.g. tandem ICPMS)].
- Developments with other Mass Spec technology e.g. use of AMS to analyse very active material at high dilution.
- Photonics – development of laser technology e.g. LIBS, RAMAN for in-cell or glovebox analysis.
- Novel gamma spectrometry techniques e.g. software or hardware for Compton suppression or coincidence counting, new gamma detection materials or advances with imaging.
- Microfluidics or automated/semi-automated process systems – for radionuclide separation in-lab (fume cupboard/cell/glovebox) or in-situ.
- Artificial intelligence and/ or machine learning – advances in software for improvements in resolving spectra and peak stripping.

- New gaseous sensors e.g. with lower limits of detection (LOD) and ability to identify radionuclides.

(A.3) Characterisation of materials in sealed containers

Improvements in existing non-destructive assay methods e.g. for fuel/fissile material content in cans and other packages. In-line, real-time materials characterisation, e.g. fuel/fissile material content of sludge during transfer/pumping operations or SNM and uranic residues.

- Elemental analysis of materials in sealed containers (high active).

- Determining the contents of a concrete lined drum without opening it.

(A.4) Universal sampling tools

Developments in simple universal sampling tools to collect representative samples from solids, liquids or sludges that can be deployed in constrained spaces (e.g. through small apertures) or at height and potentially in high radiation areas.

(A.5) Innovative tools and techniques which can be used to measure or estimate the activity of a waste item or package.

(A.6) Improving characterisation techniques at waste category boundaries.

Specifically, in the understanding of errors, accuracy and precision and in the confidence levels of 'decision making' and/or 'acceptability criteria' with respect to (correct) waste categorisation.

(A.7) Analytical methods for the low-level determination of Persistent Organic Pollutants (POPS)

For example, PFAs (Per- and polyfluoroalkyl compounds). There is particular interest in determining the concentrations of POPs in radiologically active samples.

B) Land Quality

(B.1) Development of the understanding of the migration of radioactive and chemotoxic contaminants from buried concrete structures or land contamination is a fundamental research topic. This understanding would support broader environmental system understanding for compliance, stewardship, and closure activities. Key physico-chemical processes of relevance to the UK nuclear operators research interest include aspects of mechanisms of mobilisation of contaminants into the environment such as diffusion & desorption, and the generation of modelling and assessment tools to support the production of more robust environmental safety cases. This research theme extends to the development of effective characterisation methods of such physico-chemical properties and may consider aspects of concrete aging or existing aged disposal systems.

(B.2) The communication of assessment uncertainties to stakeholders (mainly the general public) remains crucial for succeeding in the decision-making process (in alignment with the NDA Value Framework) required to close sites. The development of effective stakeholder engagement tools related to the acceptability of the long-term safety of radioactive waste disposal and management of contaminated land in situ is an essential research area. This theme focuses on the perception and comparison of uncertainties from different activities. Key challenges include but are not limited to assessment of variability, the combination of uncertainties, or the complexity in picturing very low probability events.

(B.3) The management of the accumulative uncertainty is fundamental to a good decision-making process. Nuclear industry may be affected by over-conservatism in decision making, generated by a compounding effect. Approaches and tools to better quantify the uncertainties on human health impacts in environmental assessments are currently to be improved to drive better decision-making. Areas of specific interest are:

- Uncertainties for longer-term assessments (millennial timescales).
- Quantification of inter-play between correlated and uncorrelated uncertainty contribution.
- Mapping of time evolution of the uncertainty contribution.
- Improved approaches to address the sampling strategy conundrum.

(B.4) The expansion of the performance envelope of sampling equipment and analytical instruments to address the radioactive contaminants found at nuclear sites, and to allow characterisation of groundwater conditions. Areas of interest are, but not limited to:

- Novel instrumentation or techniques.
- In situ, higher frequency monitoring.
- Difficult-to-detect radionuclides.

(B.5) Novel investigation techniques for radioactive discharge pipelines from nuclear sites are of interest, including:

- Methods for determination and application of fingerprints (using easily measured gamma emitters and the relationships between radionuclides of interest and easily measurable physical parameters (pH, Eh, etc.)) to determine the presence of and quantify more 'difficult to detect' radionuclides.
- Innovative remotely operated vehicle designs to characterise pipelines.

(B.6) The application of machine learning and/or artificial intelligence is essential to improve support and advance work. Their application has potential for freeing human resources from repetitive tasks, supporting humans in decision-making, and offers enhanced data interpretation. Areas of interest are:

- Applications of machine learning and/or artificial intelligence to novel sensors and robotics for the characterisation and monitoring of radioactively contaminated land and groundwater.
- Deployment of natural language processing (NLP) for capturing information from historical records.
- Use of machine learning methods to review historical laboratory analytical information to understand the presence of contaminants of currently unknown concern.
- Automatic generation and checking for consistency of safety case documents.
- Use of reality-capture techniques to digitise environmental features specifically related to land quality and historical land features.
- Construction of metadata for existing dataset.

For projects relating to applications of artificial intelligence, please refer to and consider the sub-section at the end of this document when applying to the call.

(B.7) The development of innovative techniques for groundwater remediation or the remediation of radioactively contaminated land is of interest. In particular, research should address issues arising from long-term consequences of remediation which may have an impact upon sustainability and our responsibilities to future generations. Areas of interest are, but not limited to:

- Deployment of biotechnology to groundwater and land remediation.
- Deployment of techniques relying on chemical remediation.
- Effects of climate evolution on the success of the remediation activity.

(B.8) Research to develop the understanding of the fate of radioactive particles in the environment:

- Numerical modelling of the transport and dispersion of radioactive particles in the marine environment.
- Analysis and simulation of the degradation mechanisms affecting a range of radioactive particle types in the marine environment.
- Understanding the fate and characterisation of land contamination in the biosphere.

(B.9) Research to develop understanding of local landscape evolution and climate change over the multi-millennial time scales. This includes, but it is not limited to, the numerical modelling of the evolution of the coastline in the context of high-resilience bedrock.

C) Decommissioning

(C.1) Remote deployment methods to enable characterisation, inspections, deplanting and demolition.

The ability to identify "what" is "where" within an enclosed radiological environment enables proportionate post operational clean out (POCO) and decommissioning plans to be produced. The ability to take measurements at the workface, within vessels, pipes and a cell will markedly reduce the burden upon existing labs and minimise the need for samples, coupons etc.

There is a need to focus on pipeline deployment methods. The navigation of pipelines is a problem yet to be solved, particularly in long (40 m), thin (2 inch diameter) pipes. In addition, there is a need to deploy inspection devices, decontaminants or other tools both inside and outside of the pipework.

Development in this area has the potential to significantly reduce radioactive waste volumes, by enabling easier characterisation and sentencing to underpin decisions on management and decommissioning of inaccessible structures. This challenge also extends to being able to access/ characterise below ground marine and buried discharge pipelines to determine the end states and demonstrate the residual risk. To support such activities, it is realised that remotely operated vehicle (ROV) or unmanned aerial vehicle (UAV) technology may be required.

Further to the above, the scope of deplanting and demolition covers activities such as the size reduction of structural items, potentially metals and/or concrete, that could be undertaken in high-radioactivity and/or high alpha areas, for example, to support reactor decommissioning activities. As such, technologies are required that can undertake such size reduction activities to potentially support the removal of items and/or the packaging of items to reduce dose to workers, to achieve and enhance the size reduction of the wastes in question and to reduce the generation of secondary wastes, whilst being compliant with operating in a high hazard environment and the intended disposal routes.

A specific area of consideration would be the use of conventional demolition techniques in nuclear decommissioning. Another is research into novel and innovative demolition techniques that could be used for future decommissioning plans/ works, such as bio shield demolition. A third is combining robotics and AI with conventional demolition techniques.

A key consideration for all technologies researched under this topic (and others) is the radiation tolerance of the equipment and the ability to decontaminate following usage.

(C.2) Asbestos management

Asbestos management is a priority area to overcome the challenges relating to retrieval and packing/ disposal as part of decommissioning plant and structures e.g. reactor vessels. For Magnox, it has the potential to be the dominant risk to workers, given the volume of material and its friable nature. Disposal options i.e. melting or chemical destruction vs landfill are under investigation, but there is a significant R&D gap in areas such as remote retrieval and hazard management aspects to facilitate decommissioning.

There is also the challenge for disposability, where asbestos may have low levels of radioactive contamination, and so would be consigned to the Low-Level Waste Repository (LLWR). Again, there would be a preference for asbestos-containing materials (ACMs) to be in a non-friable form to meet the LLWR safety case disposability requirements. (Note above where alternative approaches are being explored, the goal will be to remove the hazard).

(C.3) Managing ageing assets and conventional decommissioning hazards

Given the long timescales for decommissioning, there is a need to manage and maintain plant, buildings and structures until they can be decommissioned. The condition management of aging assets covers material/ structure degradation, including aging steelwork and reinforced concrete, which is an area that would benefit from R&D, as well as understanding the balance between using the condition and predicted condition of assets to inform decommissioning priority.

Particular areas of interest are:

- Long-term monitoring of ageing assets using robotic/ remote platforms.
- Condition based management of ageing assets (based upon the monitoring data and application of AI).
- Risk-informed asset management process to support prioritised decommissioning.

(C.4) Sorting & segregation & minimising waste volumes (including graphite)

Segregation of waste to achieve lower waste volumes for disposal e.g. contaminated brick/ concrete.

Application of automated systems e.g. systems which allow quicker identification of wastes. Review the potential to use this technology across the wider NDA estate.

Given the regulatory and government drive for sustainability and zero waste, there is increasing concern regarding disposal of Very Low-Level Waste (VLLW) / Low Activity-Low Level Waste (LA-LLW). One of the barriers to resolving this is the lack of a technology that can be deployed on a large scale for the decontamination of concrete. This prevents reclassification to Out of Scope (OoS) and the potential to open different uses of the material to reduce the focus on disposal.

Methods that allow for the segregation of contamination from a substrate can enable the consolidation of contamination into a smaller, yet more active waste form e.g. Low Level Waste (LLW) to very low volume Intermediate Level Waste (ILW). The methods should also consider size reduction, dismantling and waste handling. Also, improvements in packing efficiencies e.g. compaction, super compaction, cutting techniques, thermal treatments.

There is a huge graphite inventory across the NDA estate destined for a Geological Disposal Facility (GDF). The means to compact to a coal or diamond like material would enable easier handling, or if further reuse could be found e.g. active graphite material could be used to create a C14 battery, which if in a diamond form is a self-calibrating radiation detector.

Research is required to identify which wastes could be suitable for reuse to minimise waste volumes, e.g. feasibility of using VLLW/ LLW as shielding materials for construction in new build or optimising concrete waste for use as infill. This may tie in with graphite reduction/ reuse. A specific subject to be considered is the identification of technologies to increase the beneficial re-use of activated (as opposed to contaminated) metallic components. Understanding whether it is feasible to separate radionuclides from activated metal to utilise conventional routes for re-use.

(C.5) Retrieval of heels and residues/ methods for penetrating vessels and pipework

There are a large number of tanks and associated pipe work/ vaults/ tubes/ sumps/ ponds which are difficult to access, and although bulk volumes can be removed, there is a need for easy removal of any remaining heels and residues. Specifically:

- The means to penetrate vessels and pipework in a secure manner.
- Remote tools for size reduction, dismantling and waste segregation (general waste handling).
- Big challenges arise from all dose rate levels, sludges & solids of different rheology and physical properties.

The integrity of the seal is important to eliminate any release fraction when applied, be water/ chemical proof and functional for several years after insertion to allow further washout of plant etc. Further learning and development of sludges and solids is needed, covering different methods e.g. hydrogen hot tapping, what works well, challenges etc. Again, cell geometry/ environment makes this a challenge and a topic for further research.

(C.6) Coastal monitoring and climate change monitoring during the C&M periods

How we build up a baseline picture then monitor and compare over the Care and Maintenance (C&M) period, looking at climate trends and storm events.

NATIONAL NUCLEAR LABORATORY

D) Spent Fuel & Nuclear Material

(D.1) Behaviours of irradiation sensitised AGR fuel cladding

Research into the behaviours of irradiation sensitised AGR fuel cladding under moist and dry storage conditions, including the potential impact of stress and the microstructure of the cladding; notably behaviours which could compromise future containment or mechanical strength. This might consider the impact of surface oxides, potential storage-gas compositions and impurities including the influence of variables such as temperature, humidity, radiation dose rate and free or 'fixed' moisture presence.

Here NDA is interested in developing and testing modelling approaches, to enhance our understanding of AGR cladding corrosion in air. The following are included as examples to support the development of submissions:

- Models that can be adapted from our pond storage knowledge and explore the mechanistical interaction of thin liquid films or liquid droplets in air with irradiated AGR fuel cladding.
- Thermodynamic modelling of the system – water chemistry, surface chemistry and the combined effect of radiation.
- The use of artificial intelligence (e.g. neural network) modelling to interrogate corrosion data from research programmes or published corrosion data from simulants that resemble AGR cladding (e.g. ideally stainless-steel grades with a similar composition or another stainless-steel grade with an extensive dataset and known irradiated history).

(D.2) Alpha (α) damage and helium

Plutonium and related materials are α active. Each α decay results in local damage to the host material, heat and a helium atom which can subsequently be released, pressurising any sealed systems. Helium pressurisation is a current topic in the lifetime of storage cans. Helium is a factor in the pressurisation of MOX fuel rods during irradiation and subsequent storage/disposal and will also be a factor in immobilisation products and any relationships between α damage and leaching. NDA is interested in proposals in α damage and helium distribution in special nuclear materials, both product powders and engineered ceramics relating to interim storage or final disposal. In particular, the understanding of helium behaviour in wasteforms over the long term after GDF disposal is an important technical challenge to the Disposition programme and NDA intend to undertake further work in this area in partnership with NWS. This will include both experimental and modelling work that can be shown to be relevant to this problem. Any proposals would be ideally targeted at supporting the NDA mission but naturally in any PhD programme there will be an element of skills/ capability development.

(D.3) Absorption of species on fuel precursor powders

Product powders are known to absorb gases from the atmosphere. This can include atmospheric gases such as CO_2 or H_2O, products of radiolytic reactions such as nitrous oxides or in some cases HCl from degradation of storage packaging. The conditions under which these species remain chemically bound or can be released can impact on continued storage or disposition processes, i.e. during external heating from a calcination or sintering process. However, the details of the chemical bonding to the product surface are not well understood. Recent studies with chlorine-contaminated materials show there are a range of possible chemical states some of which are more readily released during stabilisation treatments, and it is possible for the chlorine to 'switch' state over time. Gaining better insights into the nature of bonding between absorbed gases and PuO_2 and the conditions under which they remain stable is a further R&D interest. NDA would welcome proposals that seek to understand this issue using characterisation methods that may not readily be available in active laboratories, providing such proposals are within the bounds of radiological protection and other relevant regulation. There is an element of both supporting the mission and capability development anticipated with this proposal area.

(D.4) Plutonium immobilisation

The NDA is currently evaluating production processes for plutonium immobilisation. This includes the manufacture of zirconolite by HIP (Hot Isostatic Pressing) and disposal MOX, manufacture of regular uranium-based MOX fuel but intended for disposal to a GDF, not irradiation.

(D.4a) Immobilisation processes

There is a need to develop and optimise the production processes for immobilised products and the waste formulations used. This can include both optimising the current dry powder routes, e.g. milling, granulation, conventional sintering or examining the relevance of new techniques such as spark plasma sintering (SPS), flash sintering or similar.

The NDA is also interested in novel methods to monitor or characterise powders during processing, e.g. particle size distribution that could be applied to nuclear materials to gain better insight into how powder properties change during fuel or waste manufacturing and the subsequent impact on product quality.

(D.4b) Durability of immobilised products

Linked with manufacturing routes, NDA also welcomes proposals examining the durability of these wasteforms in storage or geological disposal. This could be in terms of the relationships between manufacturing and future durability. For example, any role of ceramic grain size/ porosity distribution in disposal performance or could be examining more fundamental properties of the system, for example, differences in mobility of neutron absorbing and fissile species in a GDF environment.

There is an element of both supporting the mission and capability development anticipated with this proposal area.

(D.5) Preparation of new surrogate materials for AGR cladding.

During nuclear reactor operations Advanced Gas-cooled Reactor (AGR) fuel cladding can undergo changes in physical and chemical properties as a consequence of neutron damage and thermal effects. These changes generally occur at the lower and cooler sections of the AGR fuel stringer and is known as the radiation induced segregation (RIS) phenomenon. This portion of the inventory can be vulnerable to corrosion when exposed to corrosive species and based on historical events, NDA know this portion to be susceptible to intergranular stress corrosion cracking (IGSCC). Since high pH levels have been instated there has been no occurrence of AGR fuel failure. However, this mitigation does not completely remove the risk of localised corrosion to occur, and NDA recognises the need for a detailed understanding of its impact on the AGR fuel lifecycle.

There are broadly two areas where additional material science studies could help us unravel key knowledge gaps:

- A greater understanding of the RIS phenomenon, through the creation of micro engineered materials showing similar RIS features to AGR fuel cladding. Ideally the material will be used to inform where the current RIS model can be developed and to provide alternative means to explore the corrosion behaviour of RIS-affected steels.
- Methods and techniques that could potentially recreate similar failure sites in materials (i.e., similar to IGSCC sites observed in AGR fuel cladding). In this instance NDA will be interested in exploring how the 3D network produced can impact on ingress of water during pond storage and its removal during drying processes.

(D.6) Managing gas generation in sealed containers of fuel

Sealed containers of spent fuel e.g. for storage or disposal of the fuel might, in some circumstances, contain material that could generate gas e.g. water that could undergo radiolysis. This gas generation could have several undesirable consequences, e.g. over-pressurisation of the containers or the formation of flammable gas mixtures within the containers. There is an interest, therefore, in novel methods that could be used to detect, quantify and manage gas generation inside sealed containers of spent fuel.

E) Waste Packaging and Storage

(E.1) Manufacture of containers that minimise or eliminate the need for metallic components as part of the design. Research would have to demonstrate benefits in terms of reduced mass, less gas generation from post-closure corrosion, reduced CO_2 in construction, etc. but it would also have to demonstrate equivalent performance to GDF/LLWR approved containers in normal & accident conditions.

(E.2) Containers designed to be used in GDF and/or LLWR surface vaults and/or near-surface disposal (NSD) silos. Currently containers tend to be specific to the destination meaning projects need to make early decisions on which one to use. Sometimes during retrieval, it becomes obvious the waste could go to a 'lesser' category route in a cheaper container or without the need for interim storage. But by then it's too late because the plant is designed around a container that can only go to GDF. Designing a container that could go to any facility (& is transportable) would be highly desirable.

F) Sustainability

(F.1) Balancing pace, priority and sustainability and the consideration of intergenerational equity to drive the NDA mission

The NDA's mission is forecast to last over a century. NDA would like to explore intergenerational equity considerations in relation to balancing the pace and priorities of civil nuclear decommissioning, considering the various impacts at the local, regional and national community scales.

(F.2) Calculating lifecycle carbon emissions from decommissioning

Whilst several studies have compared the carbon emissions of electricity generation for different types of nuclear and non-nuclear power production, little is known about the full lifecycle carbon cost including historic and forecast decommissioning activities. Research could focus on:

- Calculating emissions from operation and decommissioning of Calder Hall, Magnox sites and AGR sites.
- Emissions to date from all the legacy and research sites.
- Aiming to find a life cycle assessment (LCA) CO_2 figure for each unit of energy from Magnox reactors whilst decoupling all non-power factors like defence, research, etc.
- Comparison to decommissioning of other energy technologies.

(F.3) Sustainability in decommissioning and the contribution to trade and HMG agendas

Considering the national drive to reach Net Zero by 2050, sustainability will be a key factor in future decommissioning activities. NDA are interested in research pertaining to tools, techniques and processes that can be used to embed sustainability into nuclear decommissioning, bringing in experience and learning from other sectors where appropriate and considering any unique challenges to nuclear. How can nuclear legacies be transformed into opportunities for sustainable development which contribute to trade and align with HMG agendas?

(F.4) Sustainability leadership and a culture of leadership in large organisations

To enact a culture of sustainability within an organisation, the concept must be embedded at all levels of leadership. NDA are interested in research on how to develop an instinctive and consistent understanding of sustainability which allows informed decision making, personally and professionally, expediating leadership at all levels within the nuclear industry, across remote sites and in an aging demographic.

(F.5) Sustainability and social impact benefits of non-monetary investments in communities

Nuclear decommissioning activities often impact local communities beyond direct cash flow into the local economies, for example through improvements to education and skills, research and development, specialist supplier developments and utilisation as a show case. Research is required to identify and develop approaches for assessing the sustainability and social impact benefits of non-monetary investments in communities. This could include comparison of nuclear sites to other sectors, local community programs etc. especially those linked to energy or use of natural resources. Any learning from experience and how it might be applied to the nuclear sector should also be considered.

(F.6) Understanding attitudes and behaviours that underpin culture and define environments that impact on inequalities

The nuclear sector workforce is often cited as lacking diversity, especially at rurally located sites. We are interested to explore factors that influence diversity and inclusion including:

- Structures and culture: challenging organisational and societal barriers to entry for under-represented groups into the nuclear sector.
- Employee perceptions on managing diversity in the workplace.
- Understanding senior leaders influence on setting tone and culture and the impact on diversity and inclusion.
- Bias? Is it really unconscious and how it might be impacting recruitment decisions? How might it be mitigated?
- Engaging the disenfranchised majority to see the benefits of diversity and inclusion.

G) Open Criteria

This category will be left open for civil nuclear decommissioning related proposals that might be of interest to the NDA and are not encompassed by the above themes. This would also cover research supporting the NDA's mission in effluent treatment and management and alpha-decommissioning of contaminated plant and wastes. When constructing proposals for the open theme, respondents should ensure their idea aligns with the NDA mission (see NDA Strategy 2021) and demonstrate this in their proposals.

In addition to the proposals outlined, the NDA is specifically interested in research proposals in the following areas:

(G.1) Low CO2e construction for decommissioning

Some civil decommissioning activities will require the construction of substantial infrastructure such as new intermediate storage facilities and eventual disposal facilities. Research is required into how to minimise the carbon footprint of these structures whilst maintaining the necessary engineered levels of confidence during their operational lifespan.

(G.2) Low CO2e alternatives for waste packaging

Nuclear waste packages often have a high CO2e either through the use of energy intensive construction materials for the outer packaging (e.g. steel) or via the waste matrix itself (e.g. grout). These materials are likely to become more expensive or less freely available in the future, as well as contributing to the carbon footprint of the NDA group and our supply chain. Research is required into alternative, low CO2e materials for use in waste packaging that can meet the necessary storage and disposal requirements. This research should consider how to maximise recycling into the process, e.g. through the use of recycled concrete or additives such as graphite

(G.3) "Smart" cement

Aligned with the characterisation theme, the NDA is considering the management of waste packages in storage. There is an interest understanding the feasibility of novel methods that other industries are exploring that could be used to detect, quantify, and manage the contents of cementitious waste packages in storage.

(G.4) Shared Waste streams between decommissioning sectors

The NDA wants to ensure that our mission outcomes and the journey to deliver them are sustainable. Different decommissioning sectors share this objective. Research is required to understand how the concepts of reuse and recycling can be applied to waste streams, particularly those that are shared across different industries, such that the interplay between sustainability benefits and the economic case is understood.

(G.5) Cross industry collaborations

Recognising the cross-industry similarities between the decommissioning missions of the NDA and the oil and gas community, we would be interested to receive research proposals that build on these synergies and address common challenges. More information on the challenges surrounding decommissioning in oil and gas can be found here:

[Research – The National Decommissioning Centre (ukndc.com)](#)

Whilst this element of call has not been formulated in conjunction with the Net Zero Technology Centre or the National Decommissioning Centre, any relevant proposals will be shared and assessed together with these organisations.

(G.6) The role of artificial intelligence (AI) in risk prediction analytics across the nuclear industry

Reducing both hazard and risk are core drivers in NDA's mission. Developing improved models to utilise the power of AI in accessing, understanding and running multiple scenarios to potentially output suggestions for risk predictions is an incredible opportunity. The research may cover the data types and values of human created archived data and how AI can deeply analyse the outputs over many decades in the past. Research across many industries on how predictive analytics are being enabled would also be of great value. Also, understanding the leading AI data models and how AI can learn from other AI deployments across aligned organisations and the implications of those outputs. The outputs would also be interesting across the ever-increasing horizon scanning predictive data processing.

For projects relating to applications of artificial intelligence, please refer to and consider the sub-section at the end of this document when applying to the call.

(G.7) The challenge of modelling long term future risk uncertainty

One of the impacts of policy responses to the Covid-19 pandemic has been the increased level economic uncertainty about the future. For all sectors there is a large increase in uncertainty, particularly around spending plans and revenue projections. Research into new models and how we exploit data to help show long term future risk exposures and areas for management are needed. How multiple models could be created to give various confidence level aligned outputs coupled with new analytics platforms would be of great interest. Developing new innovative quantitative models to estimate the likelihood and potential impact of long-term future risks in new ways would add great value to the planning we have in the nuclear industry which is mapping out activities over 100+ years into the future.

(G.8) Psychological safety

Creating a psychologically safe environment within complex organisations is essential for continued success, and this is further enhanced within the context of complex nuclear decommissioning activities.

The extent to which organisational members feel psychologically able to speak up, express their views and challenge the status quo can impact safety related decision making and levels of participation. Research is sought into the mechanisms involved in the creation of high levels of psychological safety and how that influences the way that individuals frame, carry out and respond to organisational requirements. (For example, carrying out safety investigations, reporting of near misses, developing a culture of innovation and the psychological safety barrier to collaboration.)

(G.9) Learning Organisation

Being a 'Learning Organisation' informs how a business continually improves itself through using its own experiences and those of others to create its own meaningful knowledge. This is transferred across the organisation to positively impact safety and delivery performance. Further study is required into the attributes and requirements needed in order to install a strong learning organisation, specifically within the high hazard, high reliability context of nuclear decommissioning.

(G.10) Decommissioning culture

Working in a nuclear decommissioning environment is a unique experience where success is linked to subtractive rather than additive activities, often within physically challenging work environments. Does working on nuclear sites undergoing decommissioning require specific approaches to establishing a culture to enable success? What are the implications for leadership activities, setting expectations, and unspoken elements of the employer/employee psychological contract within a nuclear decommissioning environment?

(G.11) Culture & behaviours within challenging environments

Working in a nuclear decommissioning environment is a unique experience where success is linked to subtractive rather than additive activities, often within physically challenging work environments. When working in challenging nuclear decommissioning and remediation environments, what are the specific elements that organisations need to be mindful of when planning and implementing cultural and behavioural strategies? This may include potential impact on morale, recruitment & retention, leadership style and levels of compliance.

(G.12) Knowledge retention

The nuclear industry faces a huge loss of knowledge as the workforce ages and retires, each taking decades of knowledge and experience with them. NDA are interested in research addressing how this technical information is best captured, stored and made readily accessible to those who may find it useful. How can the information augment existing resources such as the nuclear archive, and possible future object collection?

Furthermore, can this structure be used to capture oral histories of the people and communities affected by the civil nuclear industry. How is this ethnographic information best captured, recorded and made available to those who want to access it, and how can we apply this methodology to legacy audio-visual collections.

(G.13) Developing a framework for understanding asset performance improvement opportunities across the NDA group of operating companies

When mission delivery targets are missed by business units, costs and risks can increase. NDA are interested in identifying better ways (such as loss logging and AI) to understand how the associated assets are performing in parallel to capturing and implementing improvement opportunities to reduce any gaps. Further research is required to identify opportunities in the quantification of asset performance in areas such as:

a) Collation of loss logging and common issues/benefit

b) AI across condition reports (Atlas)

c) Strategic planning and policy deployment at NDA

For this research, the PhD researcher could be seconded into the NDA Asset Management & Continuous Improvement (AMCI) team to allow access to real data and real problems and help identify solutions.

(G.14) Developing a performance focused approach and culture for mission delivery improvement

When mission delivery targets are missed by business units, costs and risks can increase. Focus and culture within the industry can negatively impact the required performance where nuclear is seen as different (harder/more complex) when in fact many of the assets and value streams are similar to many other sectors (such as oil and gas). The NDA would like to identify better ways to achieve a performance focused culture for mission delivery improvement.

For this research, the PhD researcher could be seconded into the NDA Asset Management & Continuous Improvement (AMCI) team to allow access to real data and real problems and help identify solutions.

Additional Considerations

The following additional topics may be considered alongside bursary proposals for any of the theme areas (A-G). N.B. Inclusion of these elements is not mandatory for bursary proposals, and applications without these elements will not be "marked down".

Artificial intelligence and other projects requiring access to NDA owned or managed data:

Artificial intelligence (AI) is a growing topic in the nuclear sector and research into its application within NDA's decommissioning mission requires special consideration when applying to the NDA bursary call.

- Access to NDA owned data must be identified as a risk within proposals. Applicants are expected to engage with potential sponsors to ensure that either data can be provided or that secondments into NDA group can be established to facilitate access.
- Where a secondment is required, please ensure this is correctly costed for within the proposal including travel and subsistence, security clearances and hosting/ sponsorship. Please also consider what facilities/ equipment/ software may be required as these may not be available within the NDA SLC or host organisation.
- There is currently no agreed approach to regulate AI within the nuclear sector, although ONR have done some exploratory work. Applicants may wish to consider how their solution could contribute to regulator acceptance. This could include engaging publicly with organisations and regulators in nuclear.
- Applicants should consider where the PhD can go beyond the state of the art. There have been several examples where AI has either been implemented or demonstrated by consultants or the supply chain within SLC's. It is important that any application focused on AI is aware of this research and engagement with NDA during the call process is essential to understand this landscape.

If there are further questions on this section applicants are advised to contact the call administrator who will then facilitate discussions with the appropriate sponsor within NDA group.

Collaboration with US research organisations:

Applicants will have the opportunity to include an element of collaboration with research institutions in the United States in their research proposals on topics of mutual interest to NDA and US DoE. The Project Lead for the proposal should be a UK academic and will need to have an established relationship with the

US academic/research institution with whom the collaboration is proposed. The proposal should include separate costs for any secondments and/or work in the US, and any associated supervision costs. It should also indicate how overseas working would be managed. It should indicate whether the collaboration is essential or desirable to the proposal and the associated benefit of the collaboration. If work in the proposal is deemed relevant to US nuclear decommissioning challenges, the US DoE may fund part of the proposal.

Access to UK R&D facilities for handling radioactive material:

The NDA would welcome proposals where a PhD project would benefit from gaining access to UK research facilities for handling radioactive material. Applicants are encouraged to include estimated costs of undertaking R&D using radioactive materials in the proposal where a realistic estimate can be made (e.g. based on previous experience, or through discussion with the facility operator), or alternatively to state the nature and likely duration of the work they would like to undertake highlighting whether the active work would be ***essential*** to the success of the project or would just add value. If the proposed work involving radioactive materials is judged to bring significant benefits to the project, then the NDA will consider funding this work ***in addition*** to the PhD project scope. Details of the proposed active work and information about costings and/or duration can be submitted as part of the "Supplementary information" section in the application form.

For specific guidance, please contact the call administrator at the address provided at the end of this document.

Cross industry collaborations:

Recognising the cross-industry similarities between the decommissioning missions of the NDA and the oil and gas community, NDA would be interested to receive research proposals that build on these synergies and address common challenges. More information on the challenges surrounding decommissioning in oil and gas can be found here:

Research – The National Decommissioning Centre (ukndc.com)

Whilst this element of call has not been formulated in conjunction with the Oil and Gas Technology Centre or the National Decommissioning Centre, any relevant proposals will be shared and assessed together with these organisations.

NATIONAL NUCLEAR LABORATORY

Details and further information

Funding will be available to UK academic institutions for PhD projects and 'top-up' funding for CASE awards and EngDocs in relevant areas. Only project proposals with a total cost to NDA of ≤£150,000 will be considered (exclusive of additional costs of any collaboration with US research organisations or access to specialist facilities R&D facilities for handling radioactive material – as outlined above). Eligible projects will include PhD projects involving universities or subcontractors where the bursary is used as a grant top-up to access national facilities for research involving the handling of radioactive materials. NDA does not stipulate how this money is to be spent and will not penalise proposals that utilise some of the bursary funding to increase the stipend to the PhD candidate.

To comply with the Government's protective security procedures all employees/contractors will be subject to an Industry Assurance check and a level of National Security vetting. Proposals will be assessed by a group of nuclear industry specialists. Contractual arrangements will be administered by the Direct Research Portfolio University Interaction Framework contract holder (currently the National Nuclear Laboratory (NNL)) on behalf of the NDA.

Proposals must be submitted using the submissions site which is linked from the NNL bursary site www.nnl.co.uk by 15:00 on **1st December 2023.** Further information on the call, the assessment criteria and selection process is also available by contacting the administrator, Dr Mark Bankhead directly at the following email address (mark.bankhead@uknnl.com) and can also be found within the documents posted on the NNL website.