NDA PhD Bursary Call 2022:

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

The NDA is requesting applications to its bursary scheme, 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 for the scheme 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 scheme 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.

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 £120k per project in the following thematic areas:

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

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

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(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 packages. Improved detectors 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 to improve analysis cost, turnaround and improved supply-chain capacity. Key focus is on improved analysis/assay capabilities for alpha and beta 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.

(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 ways of measuring or estimating the activity of a waste item or package.

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

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

B) Land Quality

(B.1) Development of the understanding of the migration of radioactive and chemotoxic contaminants from buried concrete structures, including mechanisms of mobilisation of these into the environment such as diffusion & desorption, effective characterisation methods and the generation of modelling and assessment tools to support the production of more robust Environmental Safety Cases.

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(B.2) Development of effective stakeholder engagement tools related to the acceptability of the long-term safety of radioactive waste disposal and management of contaminated land. This may include the representation of uncertainty and assessment of variability.

(B.3) Expansion of the performance envelope of the latest generation of sampling equipment and analytical instruments to address the radioactive contaminants found at NDA sites, and to allow characterisation of groundwater conditions (including anoxic groundwater at geological repository depths 200-1000mbgl).

(B.4) Novel investigation techniques for radioactive discharge pipelines from nuclear sites, 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.5) Research to develop the understanding of the fate of radioactive particles in the environment:

- Understanding the long-term fate of radioactive particles in marine and estuarine environments.
- Research that develops the understanding of degradation mechanisms for a range of particle types under typical environmental conditions.
- Understanding the fate and characterisation of land contamination in the biosphere.

(B.6) The application of modern techniques of machine learning, novel sensors and robotics for the characterisation and monitoring of radioactively contaminated land and groundwater. The research aim is to obtain a complete picture of contamination that can be communicated to all stakeholders in a manner useful for building confidence in remediation and end states. . Examples of applications could be:

- Capturing information from historic records.
- Construction of metadata from existing dataset.

(B.7) 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.

C) Decommissioning

(C.1) Remote deployment methods to enable Characterisation, Inspections, Deplanting and Demolition

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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 furthermore eliminate 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, to enable 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 and marine off-site structures such as buried discharge pipelines to determine the end states and methods in being able to 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 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 removal of items and/or packaging of items as waste, reduce dose to workers, to achieve enhance size reduction of the wastes in question and reduce 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. Research into novel and innovative demolition techniques that could be used for future decommissioning plans / works, such as bio shield demolition. 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. There is work ongoing as to disposal options i.e. melting or chemical destruction vs landfill, but there is a significant R&D gap in areas such as remote retrieval and hazard management aspects to facilitate decommissioning.

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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. Again, there would be a preference for Asbestos Contaminated Materials 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 destroy 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:

- 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. brick / concrete contamination.

Use of automated systems e.g. conveyor belt systems which allow quicker identification of wastes. Review the potential to use this technology across the wider NDA estate. Not so much an R&D project but more so to look into the application of these systems.

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. LLW to very low volume ILW. Such processes need to be cheap to employ and require minimal infrastructure to support it, given a context of a large LLW inventory.

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.

Identify which wastes could be identified 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 / vaults / tubes 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.

The means to penetrate vessels and pipework simply, cheaper, faster and (e.g. from MSMs) 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 is needed into sludges and solids, 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 period, looking at climate trends and storm events.

D) Spent Fuel & Nuclear Material

(D.1) Corrosion behaviour of irradiated AGR fuel cladding in damp environments

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AGR cladding can become susceptible to corrosive attacks if the material is affected by Radiation Induced Segregation; under these circumstances we also refer to cladding sensitisation, or sensitised cladding. Essentially, the phenomenon implicates a smaller portion of the inventory, subjected to specific nuclear reactor operation conditions. Practical experience provides sufficient information to confirm that cladding breaches will occur when sensitised material is kept in air, at ambient temperature and ambient humidity (or higher). There is a common consensus that humidity is a major contributor to corrosion mechanisms in dry environments, although there is a lack of understanding of the corrosion behaviour under low humidity levels. Thus, NDA is interested in exploring means to advance our current corrosion behaviour knowledge of irradiated AGR cladding (and of similar stainless steel grades) in air or inert gas atmospheres, under controlled conditions (e.g. humidity, irradiation, stress) and explore avenues to develop a modelling capability in this area. .

(D.2) Detection of onset of cladding corrosion

Research into potential novel approaches which may detect at an early stage the onset of general or local conditions which might promote corrosion of cladding or other fuel containment in fuel storage ponds. The approaches may, for example, involve real time measurement mapping of minute concentration changes of aggressive ions, or other species, or use corrosion electrochemistry measurements which may signal potential changes in the corrosion risk at an early stage. A key factor in this work should be the identification of corrosion on cladding (this may be either through bulk pond monitoring or asset monitoring of fuel elements within the pond). Promising approaches would need to be evaluated for use in caustic environments.

(D.3) 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. 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.4) 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. However, the details of the chemical bonding to

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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 priority. NDA would welcome proposals that seek to understand this issue using characterisation methods that may not readily be available in active laboratories, such as synchrotron light sources, 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.5) Plutonium immobilisation

The NDA is currently evaluating production processes for plutonium immobilisation. Manufacture of Zirconolite by HIP (Hot Isostatic Pressing) is considered one option. Alternatives including MOX fuel optimised for disposal (e.g. containing large amounts of neutron poison) are also being considered. There is a need to further optimise the production routes and product formulations for these immobilisation matrices and there are new production technologies that may be relevant, SPS, flash sintering etc. NDA welcomes proposals aimed at developing the production routes for ceramic plutonium wasteforms. There is an element of both supporting the mission and capability development anticipated with this proposal area.

(D.6) Long term ageing of plutonium

Separated plutonium is a relatively young material. Over time radioactive decay leads to a change in chemistry as americium, neptunium, uranium 'grow-in' to the material. In addition to helium generation, self-irradiation damage/heating may drive changes in physical properties, change particle morphology etc. Changes might be relevant on a timescale of decades appropriate to processing and current storage or longer term, appropriate to disposal scenarios. NDA welcomes proposals that seek to investigate how decay drives changes in relevant behaviour of product powder or engineered ceramics such as gas retention, groundwater leaching etc with a particular focus on post closure behaviour in GDF. There is an element of both supporting the mission and capability development anticipated with this proposal area.

(D.7) Localisation of activity through Bulk Pond water monitoring

Eventually, several thousand tonnes of spent fuel (mostly AGR fuel) will be marshalled into the THORP Receipt and Storage (TR&S) ponds at Sellafield for interim storage, pending final disposition, alongside a smaller quantity of other miscellaneous fuel types. The fuel will be stored in several hundred separate containers. In the unlikely event of fuel failure occurring during interim storage, the ability to respond to the incident could be strengthened if the location of the failure could be identified. There is an interest, therefore, in any methods that could be used to physically locate the source of activity release due to fuel failure, i.e. which container(s) of fuel are the source of the release. There is also an interest in any methods that could be used to distinguish between a release from the majority AGR fuel and other more minor fuel types of different composition, burn-up, cooling time etc.

(D.8) Quantitative (or semi-quantitative) determination of SNM package integrity over package lifetime.

SNM material is stored in sealed stainless-steel containers and contain material which has the potential to limit the package integrity (e.g. internal pressurisation, corrosive environments). Additionally, manufacturing of the packages and their storage (dating back to the 1970s) may have been less than optimal. There is therefore interest to develop a tool, or several tools which would enable quantitative assessment of packages which could be deployed, preferably in-situ, in order to assess the condition of packages over an extended period to allow the NDA to make informed decisions. Such attributes include outer can weld quality, internal pressurisation (either as total pressure, or partial pressure), structural integrity of the package (understanding the impact of dents, scratches and corrosion of the integrity of packages).

E) 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 https://www.gov.uk/government/consultations/nuclear-decommissioning-authority-nda-draft-strategy-for-consultation) and demonstrate this in their proposals.

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

(E.1) Functional longevity of land quality information.
Aligned with site end state and nuclear archive themes, the NDA is considering the management of information associated with long term and post remediation controls. It may be necessary for information about site condition to be available in the very long term. Parallels can be drawn from historical records which provide information regarding land use which were generated one or two millennia ago. The NDA is keen to understand from historians: the nature of records that have survived from history; why they may have been retained; how have they remained available for contemporary review; and the challenges historians have in access and interpretation. This piece of work will help inform the nature and longevity of controls to protect people and the environment as part of determining the site end state. (For description of site end state strategy development see the NDA Draft Strategy https://www.gov.uk/government/consultations/nuclear-decommissioning-authority-nda-draft-strategy-for-consultation).

(E.2) Low CO_2e 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.

(E.3) Low CO_2e alternatives for waste packaging

Nuclear waste packages often have a high CO_2e 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 CO_2e materials for use in waste packaging that can meet the necessary storage and disposal requirements.

(E.4) Nuclear Cost and Schedule Benchmarking

Research is required to identify the key elements that drive cost and schedule outcomes for nuclear decommissioning projects with a view to establishing key ratios and heuristics capable of being used to benchmark estimates for future decommissioning against past outcomes. This research could feed into NEA's proposed cost and schedule database and will aid structuring the database and help to identify the cost and schedule drivers that are most mismatched between estimate and outcome, i.e. what it is that the industry keeps underestimating. Ultimately, the research will lead to greater accuracy in nuclear provisioning and thus better strategic decision making.

(E.5) Organizational Insularity

Large industries, including the nuclear decommissioning sector, often display "siloed" behaviour, such as systemic tendencies not to seek external insights and learning from other industries. Research is required to identify the root causes of such behaviour and proposals for effective intervention and remediation, to minimise duplication of effort and ensure the swift adoption of appropriate best practice.

(E.6) Long term carbon accounting

The NDA mission will take many decades to complete and, over that time, we will need to be able to measure and monitor our group CO_2 footprint to enable appropriate planning and decision making. Research is required into the methods and predictive tools and techniques that would allow comprehensive carbon accounting to be integrated into long term strategic planning.

(E.7) C-14 radionuclide of interest for near-surface disposal

C-14 is released from a range of materials, particularly steels and graphite, in waste streams which are candidates for disposal in near-surface facilities. The C-14 is in a range of different chemical forms, depending on the source material, but a significant component is likely to be present as volatile species that will be easily transported in a gas phase to the surface environment. Another fraction may be initially released as inorganic carbonate species that are expected to interact with the cement-based encapsulation grout and be immobilised within or close to the waste packages. However, there are uncertainties around the chemical forms of the C-14 released from different waste materials. Research is required to determine the likely chemical forms and mechanisms for interaction with the surrounding

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environment. For example, will inorganic C-14 remain immobilised despite potential microbially mediated processes?

(E.8) 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. The NDA is interested in developing improved models to utilise the power of AI in accessing, understanding and running multiple scenarios to potentially output suggestions for risk predictions across the estate. 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.

(E.9) Evaluating Nuclear Heritage Value

Cultural heritage is concerned with anticipating what lies years and decades ahead in order to inform decisions around what should be preserved in the present. It enables social and knowledge-based values to be formed and transmitted forwards to shape how future generations positively view the past and derive benefits from it. There is a lack of research on the heritage value of nuclear industry in the UK, its archaeology and history. There is a risk that losses may occur during decommissioning through a failure to recognise the value of what is there. Explicit research, clearly defining those intrinsic qualities that are of value and importance, would help to ensure a responsible approach towards preserving the industry's heritage. Recognising cultural significance will also assist with establishing how sustainable or publicly acceptable various decommissioning solutions may be.

Additional considerations

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

Collaboration with US research organisations:

Respondents 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 Principle Investigator 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.

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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 material" attachment in step 7 of the application process.

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:

https://www.ukndc.com/research/

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.

Details and further information

Funding will be available to UK academic institutions for PhD projects and to SMEs seeking 'top-up' funding for CASE awards and EngDocs in relevant areas. Only project proposals with a total cost to NDA of ≤£120,000 will be considered (excluding cost 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

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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 **Wednesday 22nd December 2021.** Further information on the scheme, 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 within the documents posted on the NNL website.