NDA PhD Bursary Call 2019:

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 technical 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]. This year, up to £500,000 is available to support projects that will lead to the award of a PhD and Universities and Research Institutes are invited to make proposals in the following thematic areas:

A) Characterisation

(A.1) 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 (etc).

(A.2) Rapid and Automated Analytical Techniques

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

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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

For both (A.1) and (A.2) the key focus is on improved analysis and assay capabilities for alpha and beta radionuclides. Examples of generic nuclear industry needs linked to the themes above are provided below:

- 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,
- Improvements in Real-Time/Near-Time 'rapid' analysis methods radiological and chemical analysis,
- 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,
- Innovative ways of measuring or estimating the activity of a waste item or package,
- Improving characterisation techniques at waste category boundaries
- Understanding of Errors, Accuracy and Precision and confidence levels in 'decision making' and/or 'acceptability criteria' with respect to (correct) waste categorisation

B) Waste Packaging & Storage

B.1) Grout formulations

Security of supply, alternatives to SL formulations, alternatives to 'traditional' powders, ensuring powder quality

B.2) Immobilisation

Immobilisation/conditioning of mixed/heterogeneous waste/co-processing and deliberate mixing – compatibility of waste components and immobilisation matrices

B.3) Waste treatment and conditioning

Waste Treatment and Conditioning Technologies

B.4) Waste evolution

Tools and techniques for the monitoring of container and waste evolution, degradation and corrosion of materials, and the monitoring of waste store conditions (CCM&I).

B.5) Knowledge management

Improved or innovative technologies for Management of records

B.6) Uranium hydride

Behaviour of uranium hydride under accident conditions

B.7) Alternative materials

Research and development of alternative materials for waste container construction and improved techniques for manufacturing of waste containers.

C) Land Quality

(C.1) Contamination of concrete structures

Development of the understanding of the migration of radioactive and chemo-toxic contaminants from buried concrete structures, including mechanisms of mobilisation of these into the environment such as diffusion & desorption

(C.2) Improvement of sampling and measurement technologies

Expansion of the performance envelope of the latest generation of sampling equipment and analytical instruments to address the radioactive contaminants found at NDA sites

(C.3) Modelling and Simulation

The generation of modelling and assessment tools to support the production of more robust Environmental Safety Cases

(C.4) Stakeholder communication of uncertainties

Development of effective stakeholder communication tools for the representation of uncertainty and assessment of variability in determining the long term safety of radioactive waste disposals and management of contaminated land.

(C.5) Groundwater characterisation

Methods to characterisation of groundwater conditions (including anoxic groundwater at geological repository depths 200-1000mbgl).

(C.6) Discharge pipeline characterisation

Novel investigation techniques and remotely operated vehicles for radioactive discharge pipelines from nuclear sites, and other buried infrastructure. Including techniques to determine the presence of and quantify more difficult to detect radionuclides.

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D) Decommissioning

D.1) Technologies for the recovery and treatment of waste materials

Techniques for the recovery, characterisation and segregation of wastes (including alpha decommissioning and difficult to access areas) remote and autonomous systems are of particular interest.

D.2) Monitoring of decommissioned facilities

These include building structural assessment, monitoring containment and remote monitoring methods.

D.3) Development of decontamination technologies

These include hard to access areas e.g. pipelines and pipework.

D.4) Decommissioning tools and techniques

Smarter manual 'multi-tools' for use in hostile environments).

D.5) Remote decommissioning

For example, heel & residue removals from pipework and tanks, improved air-fed suits for alpha decommissioning or systems for manual entries into hostile, C5 environments that do not require air-fed suits.

D.6) Demolition and dismantling

Treatment or remediation of contaminated land and buildings in order to optimise the opportunity for reuse or for clean-up.

E) Spent Fuel & Nuclear Material

E.1) Fundamental mechanisms of the corrosion of AGR fuel cladding

Research into determining the fundamental mechanisms of the corrosion and corrosion inhibition of irradiation sensitised AGR fuel cladding, under pond storage conditions. This should, for example, consider the potential impact of stress and the microstructure on corrosion mechanisms and corrosion inhibition by agents such as hydroxide or boron in the presence of potential impurities such as chloride or sulphate in the water.

E.2) 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.

E.3) 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.

E.4) Alpha damage and helium

Plutonium and related materials are α active. Each alpha 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 alpha damage and leaching. NDA is interested in proposals in the area of alpha damage and helium distribution in special nuclear materials, both product powders and engineered ceramics.

E.5) 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 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.

E.6) Plutonium immobilisation

The NDA is currently evaluating production processes for plutonium immobilisation. Manufacture of Zirconolite by HIP (Hot Isostatic Pressing) is considered a front running option but other production routes or materials are still possible. There is a need to further optimise the production route for HIP -

Zirconolite and there are new technologies that may be relevant, SPS, flash sintering etc. NDA welcomes proposals aimed at developing the production routes for ceramic plutonium wasteforms.

E.7) Long term ageing of plutonium

Separated plutonium is a relatively young material. Over time radio-active 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, ground water leaching etc.

F) Effluents

F.1) Sand bed filtration

The sensitivity of sand bed filter operations and abatement performance to a range of feed factors relevant to nuclear fuel storage ponds across the NDA estate is not well understood. The challenge is to investigate the impact on performance measures (pressure drop; backwash; abatement) at a macro scale (i.e. sand bed) and micro scale (sand particles) of a range of chronic and acute challenges including the presence of organic and biological materials.

F.2) Enhanced filtration technology

The challenge is to investigate the application of enhanced filtration techniques (for example applying shear during ultrafiltration and microfiltration) to a range of conditions relevant to the post-operational clean-out and decommissioning of nuclear facilities, potentially including the incorporation of the technology in mobile/modular plants.

F.3) Novel techniques targeting organics removal

The presence of organic materials in effluents generated during decommissioning and decontamination operations represents a challenge to effluent abatement using filtration and ion exchange. Research is needed to investigate novel techniques (single or in combination) for the pre-treating or co-treating effluents in order to remove the organic material and preferably render it to carbon dioxide and water. Consideration could be given to sorption methods (e.g. using nanoparticles) and to chemical or electrochemical oxidation techniques.

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. When constructing proposals for this theme, respondents should ensure their idea aligns with the NDA mission (see NDA Strategy 2016) and demonstrate this in their proposals.

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".

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 DOE. The PI for the proposal should be a UK academic and he/she 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.

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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 less than £120,000 will be considered (excluding cost of any collaboration with US research organisations). Eligible projects will include PhD projects involving universities or subcontractors where the bursary is used as a grant top-up in order 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 National Nuclear Laboratory (NNL) on behalf of the NDA.

Proposals must be submitted using the application form available on the NNL website **www.nnl.co.uk** and need to be submitted online at **www.nnl.co.uk** by 15:00 on the **12th November 2018**. 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@nnl.co.uk**) and within the documents posted on the NNL website.