

University Research and Development

Approve Strategy (Gate C)

March 2017 Issue 2

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Executive Summary

Research and Development (R&D) is a supplemental function for the NDA as specified in the Energy Act (2004). As such NDA is required to promote and, where necessary, carry out research in relation to its primary function of decommissioning. We also have an obligation within the Energy Act (2004) to ensure that there is a skilled workforce available to undertake the work of decommissioning. University R&D performs an important role in contributing to our R&D obligations and delivering a skilled workforce. In the process of developing these skills, university R&D also affords the opportunity to investigate and pursue approaches and technologies that are novel and unproven in the field of decommissioning, and thus could not be explored or delivered efficiently via the traditional industrial supply chain.

The objective of the university R&D strategy is to ensure there is relevant and sufficient academic capability available on the required timescales to facilitate delivery of the NDA mission.

Our university R&D strategy supports the R&D strategy and is aligned with the People (including Skills and Capability) strategy, two of the NDA's critical enabling strategies. In order to successfully deliver our mission NDA needs to ensure that it is technically underpinned by sufficient and appropriate R&D and that our estate has access to the skills and capability to carry out the mission efficiently and effectively on the required timescales.

University R&D plays an important role in this delivery through:

- Maintenance and/or development of key technical skills required to deliver the decommissioning plans;
- Early-stage development of decommissioning technologies (e.g. technology at low technology readiness levels);
- Application/adaption of existing technologies to radioactive environments;
- Informing the development of strategy and policy;
- Advancement and transfer of knowledge with regard to decommissioning;
- Providing fundamental understanding of underpinning science and engineering of key processes or technologies deployed on our sites and,
- Identification of R&D opportunities arising from current and future projects

Our current university R&D strategy is that, where possible, Site Licence Companies (SLCs) (and their supply chain) influence and where necessary fund relevant university R&D programmes to support delivery of site plans. In addition, NDA will influence funding bodies and where necessary provide direct funding for a strategic University R&D programme to complement that of the SLCs.

This strategy is mature and has been in place since ~2009. This document does not recommend a significant departure from that strategy but reinforces the underlying reasoning behind it and sets out the guiding principles.

University R&D that is focused on addressing specific SLC requirements, whether technical requirements or in support of recruitments to specific roles, is the responsibility of the SLCs and their supply chain.



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NDA directly funded strategic university R&D, where necessary, is identified and prioritised so that it:

- Addresses multi-site technical needs, risks and opportunities;
- Supports key strategic decisions; and
- Supports strategic development of key technical skills and knowledge and capability.

Opportunistic R&D is a primary candidate for NDA direct university funding as it develops key skills but is often too speculative, i.e. too far away from technical maturity, to achieve SLC support. University R&D to support NDA strategy or the strategic development of key skills and capability can be identified by the NDA Strategic Authorities or through a range of sources including interaction with stakeholders and reviews of past and existing research programmes and future needs. Multi-site needs and opportunities for directly funded NDA university R&D are often identified and prioritised by the Nuclear Waste and Decommissioning Research Forum (NWDRF) and where appropriate can be funded by the NDA to ensure consistency of approach and a good balance across the Estate.

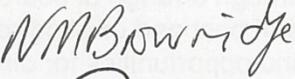
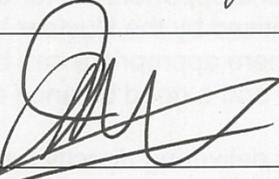
Existing mechanisms for delivering directly funded NDA university R&D include:

- The NDA PhD bursary scheme and PhD funding through Research Council collaborative schemes, to provide the next generation of well informed and highly educated potential industry employees;
- Investment in targeted capability areas such as the Research Centre for Non Destructive Evaluation (RCNDE) to build and maintain UK capability in key decommissioning skills areas;
- Impact assessment of current investments via a value scorecard method to measure progress and inform future funding decisions.

These mechanisms will be reviewed, maintained and developed as required. Wherever possible, the results of NDA funded university R&D are disseminated to the estate, stakeholders and the wider research community through a variety of methods including, where appropriate, publication and discussion at conferences and the NWDRF.

NDA and its estate are currently key funders of university based nuclear R&D, predominantly in the UK. NDA are observers to the Nuclear Innovation and Research Advisory Board (NIRAB) where UK-wide nuclear research issues are considered to ensure a coordinated approach. We also interact with a variety of industry, academic, research council and government bodies through fora such as the Energy Innovation Board (previously the Low Carbon Innovation Coordination Group), Industry-Academia coordination groups and Centres for Doctoral Training (CDTs). These fora provide opportunities to identify collaborative opportunities, obtain funding leverage and further disseminate our sponsored R&D. Through these interactions, we also recognise that there is strong support for NDA to maintain a strategic university R&D portfolio.

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1.0 Strategic Case

Research and Development (R&D) is a supplemental function for the NDA as specified in the Energy Act (2004). As such NDA is required to promote and, where necessary, carry out research in relation to its primary function of decommissioning. We also have an obligation within the Energy Act (2004) to ensure that there is a skilled workforce available to undertake the work of decommissioning. University R&D performs an important role in fulfilling our R&D obligations and delivering a skilled workforce. Our university R&D strategy is a component of NDA's wider R&D strategy as shown below in Figure 1.

The objective of the University R&D strategy is to ensure there is relevant and sufficient academic capability available on the required timescales to facilitate delivery of the NDA mission.

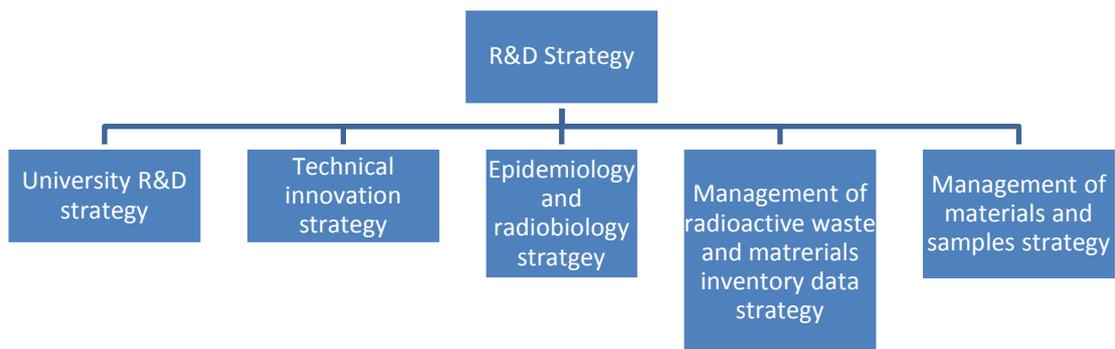


Figure 1: Component parts of NDA's R&D strategy

1.1 Topic Background and Context

Historically there has been no UK-wide overarching needs assessment with respect to University R&D relevant to decommissioning and as a result investments were possibly not as well linked as they could have been and the potential for gaps or duplication existed.

Prior to formation of NDA there was limited coordination between the University R&D programmes of the SLC-equivalent organisations. Some previous organisations, such as British Nuclear Fuels Ltd. (BNFL), sponsored themed centres of excellence at specific universities including specialist centres for radiochemistry and materials performance at the University of Manchester, particle science and technology at University of Leeds and immobilisation science at the University of Sheffield. When NDA was formed, NDA inherited any ongoing responsibility for these centres which typically had funding commitments from BNFL for 5 year periods from initiation of funding. The centres were expected to be self-sustaining beyond that period through project specific funding from a range of customers.



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However, universities are key organisations with which NDA, NDA Radioactive Waste Management Limited (RWM), NDA Site Licence Companies (SLCs) and the supply chain work with in order to deliver the NDA mission. University R&D plays an important role in supporting the delivery of the NDA mission through:

- Maintenance and/or development of key technical skills required to deliver the decommissioning plans;
- Early-stage development of decommissioning technologies (e.g. technology at low technology readiness levels);
- Informing the development of strategy and policy;
- Advancement and transfer of knowledge with regard to decommissioning; and
- Providing fundamental understanding of underpinning science and engineering of key processes or technologies deployed on our sites.

Universities offer a unique opportunity within the supply chain to explore concepts and technologies that have low or zero maturity within the nuclear decommissioning industry. Such models can be explored in the university environment in a financially efficient manner and still support the key driver of skills development, even if they do not result in development of technology that finds application on the NDA Estate.

It is therefore important to have a well-defined approach to implementing NDA funded University R&D in the form of a distinct strategy document to help allocate available funding to the most appropriate areas and encourage proactive involvement in the development of new University R&D initiatives that support the NDA mission.

1.2 Current Situation

Our current University R&D strategy, defined as an appendix in the R&D Strategy, is to communicate to universities the challenges associated with our decommissioning mission, promote existing relevant university research programmes and where necessary fund university research programmes using the most appropriate means (i.e. directly *via* the NDA Direct Research Portfolio or *via* the NDA RWM R&D programme, indirectly *via* our SLCs or collaboratively with other organisations in order to leverage our funding and increase the overall impact). It is an integral part of our overall R&D strategy and follows the same principles of promoting and, where necessary, funding R&D in relation to our primary function of decommissioning.

We are currently delivering our University R&D strategy by various means:

- Ensuring our decommissioning challenges are understood by academic researchers by engaging with appropriate University R&D programmes,
- Seeking opportunities for leveraging our investment by co-funding University R&D with research councils, universities and other funding bodies,
- Targeting direct funding of a wide skill base by supporting University R&D directly *via* the National Nuclear Laboratory (NNL), the NDA's framework contractor for University interactions.



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To ensure that NDA funded R&D stays relevant to the overall mission, NDA has set up groups such as the NDA Research Board and NWDRF to provide governance and strategic coordination and to encourage sharing of good practice between SLCs and the wider UK nuclear waste owners. The NWDRF in particular has shown good progress in determining and sharing common R&D needs, risks and opportunities across NDA's estate and considering how best to address them collectively. More recently the NWDRF Working Group on University Interactions has been formed to provide a forum for sharing progress and outcomes from existing University R&D programmes, discussing common university R&D needs across SLC's and opportunities which could be addressed by new University R&D programmes.

Examples of the university R&D initiatives that NDA has contributed funding to include:

- The NDA PhD bursary scheme under which ~7 PhD projects each year are directly funded by NDA; a call is put out each year to the academic community for PhD proposals on relevant topics identified by the NWDRF,
- Managed research council collaborative programmes such as Nuclear FiRST and Next Generation Nuclear; NDA interacts with these initiatives where relevant by sitting on the management boards, influencing the direction of the research and direct funding of projects to ensure relevance to our mission,
- Establishing and maintaining key skills and capability via investments in the DCF (supporting radiation science and nuclear engineering for decommissioning) and the NDA-RAEng chair in immobilisation science; without investment in these areas, expertise and know-how in areas crucial to completing the NDA's mission in the coming decades would be compromised.

University R&D in the UK is primarily funded by Research Councils¹ (part of the Department of Business, Energy and Industrial Strategy (BEIS)). These bodies are responsible for investing public money in University R&D in the UK to advance knowledge and generate new ideas which lead to a productive economy, healthy society and contribute to a sustainable world. Engineering and Physical Sciences Research Council (EPSRC), Natural Environment Research Council (NERC) and

¹ Royal Charter objectives for the Research Councils are:

- 1) Promote and support research
- 2) Advance knowledge, understanding and technology and provide trained researchers to meet needs and contribute to UK competitiveness, effectiveness of public services and policy, and to enhance quality of life and creative output of the nation
- 3) In relation to this:
 - (i) generate public awareness;
 - (ii) communicate research outcomes;
 - (iii) encourage public engagement and dialogue;
 - (iv) disseminate knowledge; and
 - (v) provide advice.



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Science & Technology Facilities Council (STFC) fund University R&D particularly relevant to the NDA mission. The NDA interfaces with the Research Councils via a number of routes such as Industry-Academia coordination groups and the Energy Innovation Board to ensure we communicate our needs and influence future funding to address areas relevant to our mission.

1.3 Case for Change

The current NDA approach to University R&D is mature and functions well, and this document is not intended as a reinvention of this approach, more as a formalisation of the established processes and a platform for encouraging proactive development of decommissioning related University R&D.

The production of this University R&D strategy is timely as the third iteration of the overarching NDA strategy document has recently been published and we wish to ensure that our approach to University R&D is robust, integrated with our key driving strategic themes and coordinated with other enabling strategies such as the People strategy.

We also want to ensure that our approach shares good practice, incorporates innovation and delivers against the breadth of our obligations in the Energy Act (2004).

Furthermore, there have been significant changes in the university nuclear fission R&D sector since we published our initial NDA strategy document. These changes, the NDA's reaction to them and potential future development opportunities include:

- An expanding university base

When the NDA was formed in 2005, our University R&D portfolio was largely inherited around previously committed continuing support to specialised centres of excellence, most of which no longer receive direct funding from NDA as they were intended to become self-supporting. Since then, more universities and focused study groups (such as CDTs) have begun programmes of research relevant to decommissioning. We have taken the opportunity to get involved in these programmes to shape this element of our R&D strategy and ensure that the NDA has some influence on the direction of studies and thus the skill sets of the graduates from these centres. There are further opportunities to develop our strategy going forward to ensure sufficient and relevant capability is available.

- Challenging fiscal climate

Following the 2015 government Spending Review the research councils, including EPSRC, published their delivery plans for the period 2016-2020. EPSRC, one of our key collaborators, expect their total resource expenditure to decline slightly over that period. In the current fiscal climate, it is essential we demonstrate the impact of our University R&D programme in investing now to save on decommissioning costs later. To do this we have developed a formal



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method to assess and demonstrate the impact of NDA funded University R&D to key stakeholders. We endeavor to work with our university partners to help them demonstrate the impact of decommissioning related R&D to the research councils.

- Increased interest in wider nuclear fuel cycle

The renaissance in new nuclear build in the UK, the move towards implementing a geological disposal facility in the UK for waste disposal and increased levels of decommissioning both nationally and internationally may create internal competition between decommissioning, new build and geological disposal for funding and skills. This may result in less funding and fewer skilled researchers available to support the decommissioning programmes. On a positive note, the recent House of Lords Select Committee Report on Nuclear Research and Development Capabilities highlighted several opportunities for enhancing the UK's abilities. The report outlined a plan for ensuring that those opportunities are addressed, and as part of those actions the government set up the National Nuclear Users Facility (NNUF). It is imperative that future R&D projects make appropriate use of NNUF to ensure that the capability is sustainable.

- Skilled workforce

The UK decommissioning programmes face workforce challenges in terms of an ageing workforce and a potential skills gap in subject matter experts. Initiatives to address these concerns within the wider nuclear sector include the establishment of the EPSRC funded Nuclear Engineering Doctorate Centre and the Nuclear FiRST CDT which had a combined target of producing 100 skilled nuclear post-graduates over their lifetime. Both of these schemes received their final cohort of students in 2013 and have already resulted in graduates taking up positions within the nuclear industry. The call for new CDTs in 2013 resulted in the approval of two new nuclear related centres, the Next Generation Nuclear CDT and the CDT in Nuclear Energy. They received their first cohorts of students in 2014. NDA input, both in terms of studentship provision and in-kind support, into these centres is important to their continued success.

- International decommissioning opportunities

NDA recognises the importance and benefit of looking outside the UK to make effective use of international experience in areas such as R&D and skills development. UK universities currently receive funding from the European Commission (EC) to participate in collaborative European projects relevant to decommissioning. We recognise the benefits of these collaborative projects and will continue to engage with and influence our European partners. For example, NDA RWM is taking a leading strategic role in geological disposal research in the European Union through membership of the Implementing Geological Disposal - Technology Platform (IGD-TP) and influencing the proposed development of EC funding routes to ensure greatest value for money for NDA RWM. The NDA will continue to foster links with other countries (e.g. China, France, Germany, Japan, South Korea, USA) who are engaged with, or will shortly be engaging in, decommissioning of civil nuclear facilities to ensure that any opportunities for



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mutually beneficial R&D are exploited. The NDA wants to take advantage of a coordinated UK approach to EU research programmes such as Horizon 2020.

In the past, our investment programme was generally reactive and aimed at stimulating work. Going forward, we endeavour to be more proactive in terms of identifying needs and opportunities across the NDA estate.

1.4 Aspirational Outcome

In line with our R&D strategy, it is our aim that SLCs ensure that where necessary University R&D is an integrated component of how they deliver their LTPs. We wish to ensure across our estate that this work is shared to avoid duplication and that opportunities for maximizing funding are identified and progressed.

We also want to ensure that universities themselves understand our challenges and are able to differentiate between the research needs of individual SLCs, and those that are applicable to the NDA estate and are thus potentially eligible for NDA direct funding.

Our aim is to seek maximum opportunities for leveraging of NDA estate investments with a target that we achieve at least matched funding across the University R&D portfolio.

1.5 Scope and Boundaries of the Proposed Change

The scope of this strategy covers University R&D relevant to the NDA mission and University R&D supported by the SLCs focused on technical underpinning of LTPs. It also involves working with other organisations such as research councils, universities and other funding organisations to encourage and leverage investment in R&D, taking advantage of collaborative programmes and matched funding opportunities.

Development of the University R&D strategy will focus on:

- Preparation of a forward plan for NDA direct support to targeted university R&D programmes identified as necessary for delivery of the NDA mission (this plan may include direct financial support or support in-kind);
- Influencing funding bodies to target research at the challenges associated with the UK's decommissioning programmes and supporting the arising research programmes;
- Continuing to seek opportunities for collaboration in the UK and internationally to encourage and leverage investment to obtain best value for the UK taxpayer;
- Strengthening knowledge sharing of University R&D programmes to the NDA estate and beyond; and
- Improving how we demonstrate the impact of directly and indirectly NDA funded University R&D programmes relevant to the NDA estate.



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The University R&D strategy has an interface with the People and Skills strategy to maximise the benefit of NDA investment in educational programmes. It will also take into account the NDA socioeconomic drivers when considering future financial investments. The broader aspects of technical innovation are addressed in the Technical Innovation Strategy which also supports the R&D strategy.

The University R&D strategy defines the approach that NDA will take to ensure there is relevant and sufficient academic capability available on the required timescales to facilitate delivery of the NDA mission.

The scope includes working closely with SLCs to ensure national and international good practice is shared to support advancement of knowledge, development of technologies and maintenance of technical skills and capabilities.

1.6 What Constraints Exist (Policy, Time, Regulations etc.)

In the current fiscal climate, budgets will come under significant pressure from competing demands. It will be challenging to deliver an appropriate University R&D programme where there are significant budgetary pressures not just for NDA but for other government funding bodies. Financial constraints are also linked to the length of University R&D; projects typically require at least 3 years of committed funding, and NDA often partake in RCUK funded University R&D centres whose remit extends over 8-9 years (i.e. 5 cohorts of PhD students over consecutive years).

Furthermore, as university R&D has a relatively long lead time before results can be realised and applied to extant challenges, careful consideration is required when determining appropriate subjects for this type of research.

1.7 Identify Risks, Issues, Concerns, Key Assumptions

Risks: The fundamental risk is that failure to develop and implement a University R&D strategy will lead to increased costs and extended schedule of the decommissioning plans. This will be due to the following:

- Failure to maintain key technical skills required to deliver the decommissioning plans on a timely basis;
- Failure to technically underpin key strategic decisions through appropriate university R&D; and
- Failure to deliver innovation within the decommissioning plans which may be addressed fully or in part by university R&D.

Concerns: The nature of R&D is such that the impacts of reduction in, or elimination of, R&D funding may not be felt until several years after the change has been implemented. Furthermore, once a deficiency becomes apparent, it can take many years to re-establish the appropriate skills and experience to re-start a meaningful



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R&D programme. It is imperative that sustained funding is available, to ensure sufficient capability, including facilities, is available over the required timescale.

Assumptions: It is assumed that the general funding landscape whereby the majority of UK University R&D is funded by RCUK² will remain unchanged. It is also assumed that the NDA remit will continue to be bounded to areas related to decommissioning of the UK's civil nuclear liabilities.

NNL have a remit from UK Government to maintain R&D capabilities and associated expertise in the fuel cycle of which decommissioning is a part. It is assumed that this remit will remain unchanged. NNL are therefore well placed to support the development and delivery of NDA's University R&D strategy.

It is also assumed that NNUF will lead on capital investment in active experimentation facilities. NDA will not prioritise funding of capital investment schemes or proposals.

2.0 Economic Case Credible Options

The objective of this strategy is to ensure there is relevant and sufficient academic capability available on the required timescales to facilitate delivery of the NDA mission.

2.1 List of Potential Options

A number of potential options were considered in determining how best to deliver the NDA University R&D strategy. The NDA, SLCs, supply chain, funding bodies and universities were considered as the major contributors to meeting the University R&D strategy requirements.

² Research Councils UK (RCUK) is a strategic partnership of the UK Research Councils. RCUK was established in 2002 to enable the Research Councils to work together more effectively to enhance the overall impact and effectiveness of their research, training and innovation activities, contributing to the delivery of the Government's objectives for science and innovation.



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1. NDA and SLCs rely on appropriate University R&D programmes supported and funded by others to deliver appropriate requirements for the NDA mission.
2. SLCs (and their supply chain) influence University R&D programmes funded by others to deliver appropriate requirements for the NDA mission – NDA neither directly funds or influences other programmes.
3. SLCs (and their supply chain) influence and where necessary fund relevant University R&D programmes to deliver appropriate requirements for the NDA mission – NDA do not directly fund or influence but indirectly fund *via* SLCs.
4. SLCs (and their supply chain) influence and where necessary fund relevant University R&D programmes to support delivery of their plans – NDA do not directly fund but influence other funding bodies to fund strategic University R&D necessary to support delivery of the NDA mission.
5. SLCs (and their supply chain) influence and where necessary fund relevant University R&D programmes to support delivery of site plans - NDA influence other funding bodies and where necessary NDA also provide direct funding for a strategic University R&D programme to support delivery of the NDA mission.
6. NDA directly funds all relevant University R&D programmes necessary to support delivery of its mission. SLCs fund no university R&D.

2.2 Initial Screening Criteria

The initial screening criteria for strategy development are:

- **Alignment with NDA R&D strategy:** does the option align with our R&D strategy where SLCs are required to undertake their own portfolio of R&D against their needs and where necessary NDA funds a strategic portfolio?;
- **Value for money:** it is imperative that value for money is realised for the UK taxpayer particularly in these fiscally challenging times;
- **Organisational capability:** the strategy should look to exploit the strengths and capability of the involved organisations;
- **Knowledge and technology transfer:** a successful University R&D strategy requires that the knowledge and technological advances made in universities are disseminated to wider stakeholders to maximise opportunity for benefit to be realised; and
- **Collaboration opportunities:** finding the maximum opportunity for coordination and collaboration between stakeholders will lead to a successful University R&D strategy.

Each of the options were then evaluated against assessment criteria using a traffic light system of “Red-Amber-Green”, where “Red” does not satisfy the criteria, “Amber” may partially satisfy the criteria or there is uncertainty, and “Green” meets the criteria.

The following table displays the results.

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	1. Neither NDA or SLCs fund or influence University R&D	2. SLCs influence but do not fund University R&D. NDA neither funds or influences University R&D	3. SLCs influence and fund University R&D. NDA participates indirectly through SLCs.	4. SLCs influence and fund University R&D. NDA influence but do not fund.	5. SLCs and NDA influence and fund relevant University R&D.	6. NDA directly fund all relevant university R&D. SLCs do not fund.
Alignment with NDA R&D strategy	No. SLCs and NDA are required to undertake and where necessary fund R&D.	Partially. Risk that influence on others programmes is not sufficient to cover NDA programme requirements.	It may not be necessary for NDA to participate directly if all needs are covered by SLC programmes	It may not be necessary for NDA to fund directly if all needs are covered by SLC programmes	Yes	No. NDA only fund where necessary in addition to SLC needs-based programmes
Value for money	Partial. Through no engagement, opportunities may be lost therefore overall value for money lower	Yes if breadth of requirements covered	This option relies on appropriate controls by SLCs	This option relies on appropriate controls by SLCs	This option relies on appropriate controls by NDA & SLCs	No. NDA would need to spend disproportionately to transfer knowledge back into SLCs
Organisational capability	No. SLCs and NDA are both well placed to influence decommissioning related research	No. SLCs and NDA are both well placed to influence decommissioning related research	This could work as long as influence was recognized without NDA direct funding	This could work as long as influence was recognized without NDA direct funding	Yes	No. SLCs need to influence decommissioning related research
Knowledge and technology transfer	No. Two way knowledge transfer would not take place without NDA/SLC/University interaction.	No. Risk that SLCs would effectively communicate cross-company without NDA influence.	NDA could facilitate knowledge transfer between SLCs	Yes	Yes	Two way knowledge transfer would not take place without NDA/SLC/University interaction.
Collaboration opportunities	No	There may be some opportunity for SLCs to collaborate with Universities in the absence of direct funding	SLCs would be able to directly collaborate and NDA may be able to indirectly collaborate	Yes	Yes	Benefits from collaboration unlikely to be realised if no SLC involvement

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Option 1 was discounted as it does not align with the R&D strategy and it was also resolved that the NDA and SLCs could not assume that appropriate University R&D programmes supported and funded by others to deliver appropriate requirements for the NDA mission would occur without their involvement.

Option 2 was discounted as it was resolved that the SLCs (and their supply chain) influencing University R&D programmes to deliver appropriate requirements for the NDA mission would be difficult to achieve without financial (or in-kind) support. This option was also considered to be deficient in strategic oversight due to the lack of involvement of NDA. NDA strategic oversight is necessary for knowledge and technology transfer and to maximise opportunities for collaboration.

Option 3 was also discounted due to a deficiency in strategic oversight due to NDA not actively participating.

Option 6 was discounted as NDA funding all relevant University R&D to deliver its mission is not in line with our overall R&D strategy, does not offer good value for the UK taxpayer and is not feasible for NDA to deliver from a resource viewpoint.

The credible options were identified as:

- A. SLCs (and their supply chain) influence and where necessary fund relevant University R&D programmes to support delivery of site plans – NDA do not directly fund but influence other funding bodies to fund strategic University R&D necessary to support delivery of the NDA mission.
- B. SLCs (and their supply chain) influence and where necessary fund relevant University R&D programmes to support delivery of site plans - NDA influence funding bodies and where necessary NDA also provide direct funding for a strategic University R&D programme to support delivery of the NDA mission.

2.3 Strategic Options Diagram (SOD)



3.0 Economic Case Preferred Options

3.1 Credible Options – Assumptions, Constraints and Risks

It is assumed that the current university research landscape in the UK remains largely unchanged regarding subject matter and related academic capability. It is assumed that the current level of relevant university research funding from research councils and other stakeholders outside of SLC and NDA remains broadly constant.

The primary risks with respect to decommissioning related university R&D are

- The academic capability/interest dramatically reduces, for example due to a more attractive/lucrative source of industrial revenue
- Other relevant primary funders (e.g. EPSRC) dramatically reduce or remove altogether their financial input from this programme, which in turn would potentially lead to loss of academic support.

3.2 Application of Value Framework

The Value Framework was used to assess the credible options. The attributes used were:

Attribute	Metric	Used?
Hazard reduction	-	x
Security	-	x
Safety	-	x
Environment	-	x
Socio-economic	-	x
Cost	Option cost	✓
Return	Leverage gained	✓

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Whilst it is very likely that university R&D could eventually impact on hazard reduction, security, safety, environmental and socio-economic effects across the NDA estate, it was judged that these attributes could not be used to quantitatively distinguish between the credible options as the likely benefits would not be realised for many years after the initial financial outlay.

The options that could reasonably be quantitatively assessed both fall into the cost category, and consist of the cost of performing the option, and the potential leverage gained from following that option. These are tabled below.

Option A						
SLCs (and their supply chain) influence and where necessary fund relevant University R&D programmes to support delivery of site plans – NDA do not directly fund but influence other funding bodies to fund strategic University R&D necessary to support delivery of the NDA mission.						
Attribute	Metric	Justification	Benefit or Detriment	Base data requirement	Valuation	Comment
Cost	Option cost	Cost of engaging in university R&D	Detriment	Direct NDA financial outlay to carry out this option	£ 0	Does not account for likely rise in annual outlay to SLCs that would be required to make up the shortfall if NDA stopped funding PhD research
Cost	Leverage gained	Leverage gained from other funding sources	Benefit	Leverage received from other funding bodies	~£3M/yr	Based on 3 x decom-relevant university R&D initiatives each receiving ~£1M/yr EPSRC funding

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Option B						
SLCs (and their supply chain) influence and where necessary fund relevant University R&D programmes to support delivery of site plans - NDA influence funding bodies and where necessary NDA also provide direct funding for a strategic University R&D programme to support delivery of the NDA mission.						
Attribute	Metric	Justification	Benefit or Detriment	Base data requirement	Valuation	Comment
Cost	Option cost	Cost of engaging in university R&D	Detriment	Direct NDA financial outlay to carry out this option	~£1.25M/yr	Typical annual Lot 1 spend
Cost	Leverage gained	Leverage gained from other funding sources	Benefit	Leverage received from other funding bodies	~£4M/yr	Based on 3 x decom-relevant university R&D initiatives each receiving ~£1M/yr EPSRC funding, plus iCASE and RCNDE project leverage

Both options show a significant financial benefit to NDA and so neither option can be fully ruled out by the value framework assessment.

3.3 Credible Options Short List

The credible options at this stage are still:

- A. SLCs (and their supply chain) influence and where necessary fund relevant University R&D programmes to support delivery of site plans – NDA do not directly fund but influence other funding bodies to fund strategic University R&D necessary to support delivery of the NDA mission.
- B. SLCs (and their supply chain) influence and where necessary fund relevant University R&D programmes to support delivery of site plans - NDA influence funding bodies and where necessary NDA also provide direct funding for a strategic University R&D programme to support delivery of the NDA mission.

3.4 Apply Non-Value Framework Attributes – Other Factors?

There are several key factors that contribute to the optioneering decisions that are not quantifiable, but are very important.

- i) **“Weight” carried by having multiple financial contributors from the same industry sector.** Each financial contributor to a given collaborative

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- research project (e.g. a CDT) tends to get a seat at the management board meetings and a say in the direction of future research.
- ii) **Research budgets available for SLCs.** Several SLCs have R&D budgets that do not extend to the provision of university research as it is not identified as a need on their Technical Baseline underpinning Research and Development (TBuRD) documents, however they may benefit from university R&D.
 - iii) **Estate-wide benefit of approach.** If university R&D funding was left to SLCs, it is likely that Sellafield Ltd (SL) and RWM would be the only major funders and therefore the only major beneficiaries of University R&D.
 - iv) **Needs vs opportunities research.** If university R&D funding was left to SLCs, it is likely that all university R&D would be needs-based. This would negate potential future efficiency and safety related benefits from opportunities based R&D that tends to be funded directly by NDA.

Applying these factors to the credible options gives:

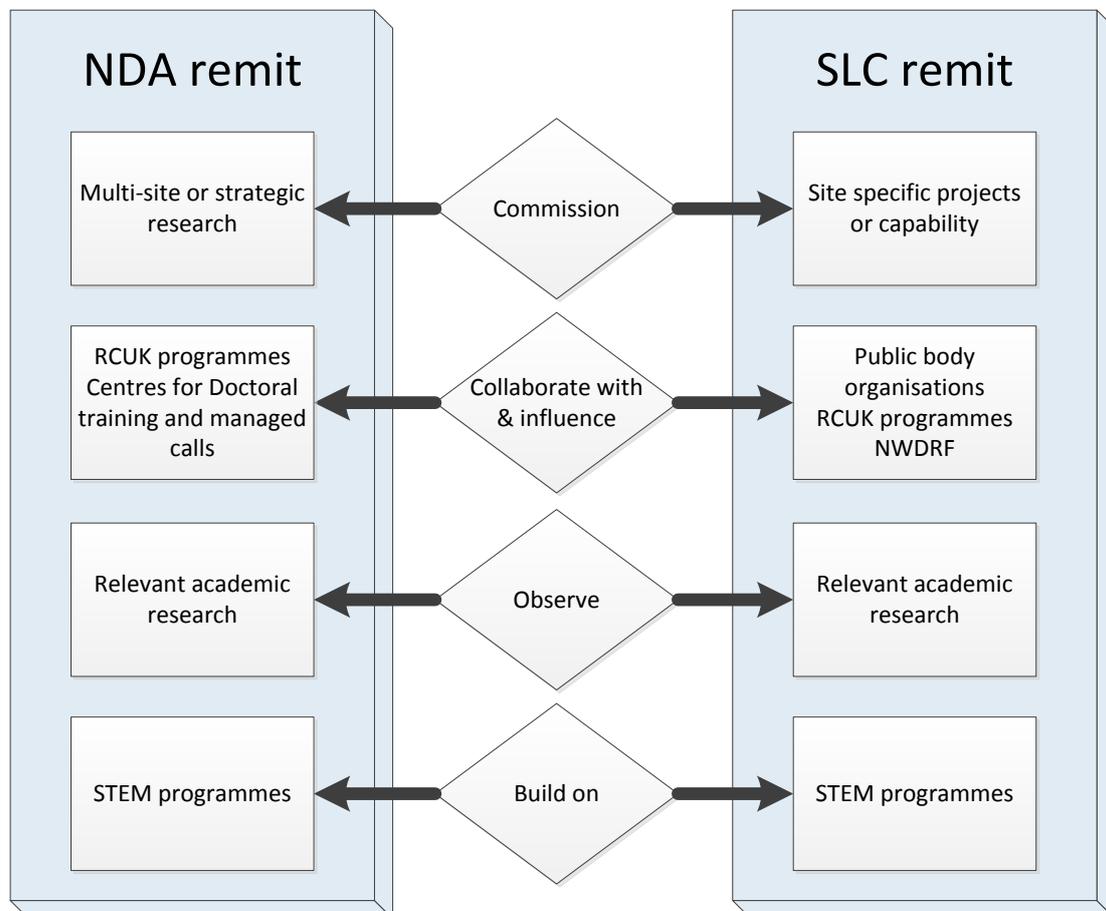
	Option A	Option B
	SLCs (and their supply chain) influence and where necessary fund relevant University R&D programmes to support delivery of site plans – NDA do not directly fund but influence other funding bodies to fund strategic University R&D necessary to support delivery of the NDA mission.	SLCs (and their supply chain) influence and where necessary fund relevant University R&D programmes to support delivery of site plans - NDA influence funding bodies and where necessary NDA also provide direct funding for a strategic University R&D programme to support delivery of the NDA mission.
“Weight” carried by having multiple financial contributors from the same industry sector	If NDA is not directly funding university R&D, there would be one less voice promoting decommissioning related research	NDA gets to add it’s voice to the promotion of decommissioning related research
Research budgets available for SLCs	SLCs with smaller R&D budgets may not participate in university R&D	NDA can support university R&D projects on behalf of SLCs
Estate-wide benefit of approach	SLCs may not disseminate findings across the estate, and would be less likely to fund multi-site university R&D	NDA can selectively fund university research that benefits the estate as opposed to individual SLCs
Needs vs opportunities research	SLCs are unlikely to fund opportunities based university research	NDA can selectively fund opportunities based university research

3.5 Select Preferred Option and Contingencies

The following option was identified as the preferred option:

B. SLCs (and their supply chain) influence and where necessary fund relevant University R&D programmes to support delivery of site plans - NDA influence funding bodies and where necessary NDA also provide direct funding for a strategic University R&D programme to support delivery of the NDA mission.

The following diagram indicates the differentiation between the NDA direct university research approach, and that of the NDA SLCs.



The whole NDA Estate should build on fundamental Science, Technology, Engineering and Maths (STEM) education courses and observe the relevant academic research in order to provide a solid foundation for more targeted decommissioning related R&D. RCUK programmes such as the Next Generation Nuclear Centre for Doctoral Training or specific calls like DISTINCTIVE need to be



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considered on a case by case basis but can provide great opportunities for direct collaboration and present openings for the Estate to influence the direction of the research. In addition, SLCs and subsidiaries need to cooperate with NWDRF and Parent Body Organisations to ensure that their identified opportunities for R&D are recognised. At the highest level, SLCs and subsidiaries are expected to identify and fund required university R&D through their TBUrDs and long term plans, whereas direct NDA funding will be reserved for university R&D that is relevant to multiple sites on the NDA estate, or will inform strategic decision making.

This preferred option represents the best value to NDA to ensure there is relevant and sufficient academic capability available on the required timescales to facilitate delivery of the NDA mission.

Several mechanisms are already in place which will help to facilitate the preferred option. These mechanisms will be maintained and developed as necessary, and include:

- NWDRF working groups and TBUrDs for determining priority areas for university R&D;
- The value scorecard approach for understanding the impact of university R&D on the NDA mission;
- Seminars for disseminating ongoing NDA funded research and knowledge transfer with the academic community;
- Identifying and supporting the preservation of key technical skills and capability through initiatives such as the RCNDE, the NDA-RAEng chair and DCF;
- Encouraging and supporting world class university R&D in strategic RCUK funded CDTs and managed calls;
- Integrating with other R&D funders including industry, government and academic bodies via forums such as the Energy Innovation Board and the Nuclear Academic Industry Liaison Society (NAILS) to minimise duplication of work and seek leverage opportunities.

Examples of university R&D areas that NDA will *NOT* prioritise under this preferred option are projects that:

- Target specific skills for direct recruitment to a specific role;
- Propose R&D that is project specific, i.e. will result in outcomes that are non-transferable across the NDA estate or wider UK nuclear supply chain.

These are examples of university R&D topics that would fall under the remit of the SLCs or their supply chain.

This reflects the strategy that the NDA has been implementing since around 2009 and so does not represent a significant departure from current practice.

The contingency option would be:

- A. SLCs (and their supply chain) influence and where necessary fund relevant University R&D programmes to support delivery of site plans – NDA do not directly fund but influence other funding bodies to fund strategic University R&D necessary to support delivery of the NDA mission.

3.6 Present Sensitivity Analysis and Strategic Tolerances

The preferred option gives the best blend of financial and political leverage (with respect to influencing academic research programmes), and benefit to the NDA estate.

It is possible that future Government spending cuts could impinge upon the university R&D budget and in that situation the contingency option would need to be considered.

In the case that the contingency option was the only financially viable option, the relationship between NDA and the SLCs with respect to university research would have to be reviewed and may require modification from its current status. For example, the NDA may need to incentivize the SLCs to pursue university research that targeted estate-wide benefits as opposed to site specific needs.

3.7 Present Stakeholder Engagement Undertaken, including SLCs

Feedback on the credible options for the University R&D strategy was sought via discussions within NDA and from participants in the NWDRF Working Group on University Interactions. Organisations attending this group include NDA SLCs, subsidiaries and NNL. Engagement was also undertaken via the Critical Enabling Theme Overview Group which includes Government stakeholders and regulators. We will continue to engage with stakeholders during the delivery of our University R&D programme.

3.8 Impacts of SEA Conclusion

This section is not applicable to the university research strategy as Strategic Environmental Assessment (SEA) is only undertaken for the Site Decommissioning and Remediation, Spent Fuels, Nuclear Materials and Integrated Waste Management topic strategies.

4.0 Commercial Case

4.1 How to Contract Delivery

In order to deliver the preferred option the majority of university R&D on the NDA estate will be supported and funded by the SLCs and their supply chain. The existing contractual arrangements in place between the NDA and the SLCs are Management and Operations (M&O) contracts. These capture the requirements for the SLCs to ensure sufficient and appropriate R&D is being carried out to technically underpin delivery of decommissioning programmes and ensure the skills and capabilities exist to deliver their decommissioning programmes (e.g. TBuRD requirements). SLCs are also required to engage with each other through the NWDRF and its associated Working Groups. The existing contract and NWDRF architecture provide the route for university R&D to be identified and delivered.

We will encourage the SLCs and their supply chain to be flexible in their contracting approach with University R&D and to seek best value for money in collaborative projects. We will continue to work with the SLCs on their approach to university R&D and encourage the sharing of good practice.

For the strategic NDA-led university R&D portfolio the contracting option with the supply chain will be a single source competed framework contract under the Direct Research Portfolio (DRP). A high proportion of this contract value is intended to reach universities and the most efficient delivery mechanism is through a single contractor chosen through an open competition. In addition, the coordination between the various university projects that would result from a single contractor was anticipated to add value to the overall university R&D programme. The framework contract was competed in 2015/16 and was awarded to a consortium led by NNL.

In cases where NDA agree to collaborate with other funders of university R&D we will develop contracting models as appropriate including Memorandums of Understanding and Collaboration Agreements.

5.0 Financial Case

5.1 Securing the Funding Source(s) for Delivery

Continued financial provision for a strategic university R&D portfolio is required and is currently met through the existing NDA R&D budget. Delivery in this manner enables NDA to meet its Energy Act requirements. The total R&D spend for financial year 2013/14 was £5m with the spend on University Interactions approximately £1.5m.

The R&D budget should be maintained to enable implementation of the University R&D strategy in line with the existing programme.



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There is strong stakeholder support for NDA to maintain a strategic R&D portfolio that includes university R&D. The budget should be flexible to allow NDA to meet its needs and ensure key strategic decisions can be technically underpinned as and when they arise.

It should be noted that regulators have the potential to require R&D work, including university R&D, to be carried out on safety and environmental issues should these not be within the LTPs.

6.0 Management Case

6.1 NDA's Plan to Manage Delivery

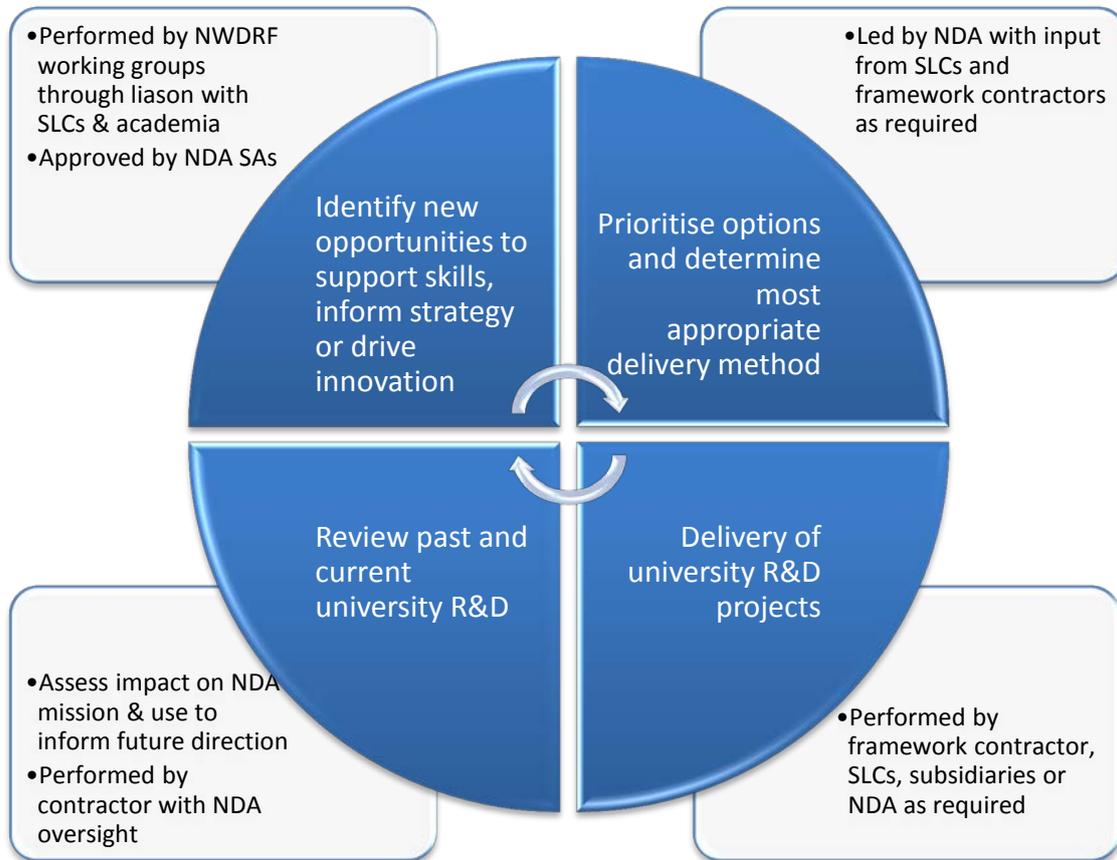
This appraisal has confirmed that the preferred option is consistent with our existing strategy. However, there are improvements to the implementation of the strategy as described earlier in this document. The NDA Head of Technology is the Strategic Authority for R&D and is responsible for the development of the university R&D strategy.

We need to plan our university R&D activities to focus effort where it is most critical to the successful delivery of the NDA mission to ensure that it is technically underpinned by sufficient and appropriate R&D and that our estate has the skills and capability to carry out the mission efficiently and effectively. The aim is that the majority of University R&D will be supported and funded by the SLCs and their supply chain.

The NDA leads a strategic university R&D portfolio to address estate-wide needs, risks and opportunities and to support key strategic decisions that are best delivered through a coordinated approach. There are key technical skills that will need to be available on a medium to long term basis and therefore we need to ensure we have a robust strategy for delivery of these skills *via* investment in University R&D. To do this, we need to know what university R&D is needed to achieve these goals, and where existing university R&D has delivered results. We need to identify what estate-wide needs, risks and opportunities exist, what key strategic decisions require support through university R&D and what key technical skills are needed in the medium to long term. In order to allocate our resources effectively, we need to decide where the need for university R&D is most pressing. Our aim is to be proactive rather than reactive.

Our plan for maintaining an effective programme of University R&D is shown in the following diagram. It is feasible that projects would start at any point on this circle.

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Delivery of University R&D

Our university R&D programmes are pro-actively managed to ensure that research programmes are aligned with our needs and objectives are met. The nature of university R&D means that the timescale for the research and training is generally over the medium to long term with project durations of typically 3 to 5 years. We expect regular interaction between the NDA estate and the provider of the university R&D facilitated by our framework contractor where appropriate. We expect regular progress reports as interim deliverables with final reports and theses provided as final deliverables. We believe that the outputs of university R&D should be freely available in the public domain through effective publication in open access journals and dissemination at conferences, taking account of any commercial or security considerations.

The university R&D programmes will have clear objectives aligned with our strategy and 5 year R&D plan, with the overall aim of raising the impact of the strategic university R&D portfolio.



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Review of past and current university R&D

Evaluation of university R&D outputs is an important step in our university R&D strategy as this is where we assess the impact that university R&D programmes are having on the NDA mission. We assess and demonstrate the impact of NDA funded university R&D to key stakeholders using a Value Scorecard Framework and associated metrics. The following six value windows have been chosen taking into consideration the requirements of our stakeholders:

- Strategic – supporting the mission
- Financial – investment and returns
- Capabilities – skills and facilities
- Knowledge – engagement and mobilisation
- Reputation – organisational and personal
- Technology – development

We will work with our university partners as required to help them demonstrate the impact of their R&D to the research councils. We may also use this analysis, combined with analysis of our past and current R&D portfolio, to inform future decisions on proposed university R&D.

Identify new opportunities

The NDA-led strategic university R&D portfolio is driven by the following:

- Addressing estate-wide technical needs, risks and opportunities;
- Supporting key strategic decisions; and
- Supporting development of key technical skills and knowledge.

New opportunities can arise from review of the SLC TBUrD documents, interactions with stakeholders or via progress of existing R&D. We use this information to identify what knowledge, technology or skills are required and on what timescales, and use the NWDRF to verify and refine our analysis.

Prioritise opportunities and select delivery mechanism

The needs are evaluated in terms of:

- Potential impact on delivery of NDA mission;
- Extent of the knowledge, technology or skill gap;
- Urgency to complete the necessary university R&D; and
- Opportunity for collaboration.

Priority will be given to university R&D projects that meet the NDA drivers and that have benefits that can be realised on appropriate timescales.



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The NWDRF is used to verify and refine the prioritisation of potential opportunities for university R&D.

The delivery method of university R&D will be chosen to successfully deliver the knowledge, technology or skill required using the following criteria:

- Value for money;
- Meeting timescales;
- Knowledge and technology transfer; and
- Opportunities for collaboration.

Existing approaches, principally direct funding awards, will be used to carry out the delivery of university R&D where they are appropriate. Small prizes may be used to incentivise excellence in knowledge transfer and communication, e.g. poster prizes at relevant conferences run by learned societies.

Current NDA University R&D Interactions

Table 1 provides an overview of current NDA University R&D Interactions along with the type of support provided by NDA, e.g. influencing and supporting, financial, etc., and an approximate estimate of the commitment by the NDA.

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Table 1: Current University R&D Interactions

Category	Activity	Institution	Description	NDA Driver	NDA Commitment	Period
Support	Nuclear Waste & Decommissioning Research Forum	NDA sponsored	NWDRF's role is to promote a common understanding and collaboration across the UK about respective R&D needs to enable the delivery of the decommissioning of the UK's nuclear legacy.	Coordination on decommissioning R&D at UK level	2 day meetings each quarter	On-going
Support	NWDRF Working Group on University Interactions	NDA sponsored	To provide a forum for sharing existing University R&D programmes, best practice and for discussing common R&D needs, risks and opportunities	Coordination on decommissioning University R&D	1 day meeting each quarter	On-going
Support/Observe	Nuclear Innovation & Research Advisory Board	DECC/BIS sponsored	NIRAB's aim is to ensure that publicly funded R&D programmes align with government industrial and energy policies, and with the NDA mission	NDA is a government funder & coordinator of decommissioning University R&D	1 day meeting each quarter	2013-2016 (minimum term)
Influence/Support	Nuclear FiRST CDT	Universities of Manchester and Sheffield	Nuclear FiRST is an EPSRC funded CDT which aims to address a doctoral skills gap in nuclear fission by funding 50 projects in 5 cohorts.	Skills gap in decommissioning	Attendance at management meetings as required (~1 day meeting each year)	2009-2018

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Category	Activity	Institution	Description	NDA Driver	NDA Commitment	Period
Support	Nuclear Engineering EngD	University of Manchester and Imperial College + 4 academic partners	The EPSRC funded Nuclear Engineering Doctorate aims to fund 50 projects in 5 cohorts.	Skills gap in decommissioning	Attendance at management meetings as required (~1 day meeting each year)	2009-2018
Support/ funding	Next Generation Nuclear CDT	Universities of Manchester, Lancaster, Leeds, Liverpool & Sheffield	The NGN CDT aims to develop future research leaders to support the UK's strategic nuclear programmes including nuclear legacy clean-up, new build power stations and, defense and security.	Skills gap in decommissioning	~5 days per year on Steering Group, dissemination and support. At least 5 NDA funded studentships	2014-2023
Support/ funding	CDT for Nuclear Energy	Imperial, Cambridge, Open	This EPSRC funded CDT will focus on new build and life extension of current power plants and include studies on decommissioning aspects and waste management.	Skills gap in decommissioning	~5 days per year on Nuclear Advisory Board and meetings/lectures. At least 1 NDA funded studentship and 2 NDA iCASE awards	2014-2023

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Category	Activity	Institution	Description	NDA Driver	NDA Commitment	Period
Support/ funding	DISTINCTIVE (Decommissioning, Immobilisation and Storage soluTions for NuClear wasTe InVEntories)	Leeds, Birmingham, Bristol, Imperial, Lancaster, Loughborough, Manchester, Sheffield, Strathclyde & UCL	EPSRC sponsored collaborative research programme focusing on spent fuel, PuO ₂ , Legacy Ponds & Silos and Structural Integrity	Developing and maintaining skills	~5 days per year on membership of International Advisory Group and attendance at seminars/meetings. 5 NDA funded PhDs	2014-2019
Funding	RCNDE	Imperial College + 5 academic partners, various industry members	The Research Centre for Non Destructive Evaluation is an EPSRC -sponsored collaboration between industry and academia to coordinate research into NDE technologies.	Capability development	Fund NNL membership of RCNDE on behalf of NDA estate. Review annual report from NNL	Annual renewal since 2005
Funding	Multiple PhD Projects	Various universities	The NDA PhD Bursary scheme has supported PhD projects, aiming to build up a pool of researchers with skills and knowledge that support the NDA mission.	Developing and maintaining skills. Delivering innovation.	Review progress report, attend seminar and selection of new projects	Annual
Support	NDA PhD seminar	Various universities, SLCs and supply chain	An event to increase awareness of NDA sponsored PhD projects and encourage and assist knowledge transfer between academia and industry	Knowledge transfer	Attend seminar, promote and disseminate relevant output where appropriate	Annual (projected)



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Stakeholder Position and Forward Plans

We believe there is strong stakeholder support for NDA to maintain a strategic university R&D portfolio.

Engagement with government, other nuclear stakeholders, regulators and EPSRC will be *via* the NDA Research Board and specific groups such as the Energy Innovation Board (EIB). Engagement with research councils will also be *via* the EIB. Engagement with universities will be through existing RCUK funded R&D programmes and the NDA PhD annual seminar. Engagement with SLCs and Subsidiaries will continue to be through the NWDRF and specifically the NWDRF Working Group on University Interactions.

Engagement with the wider research community and the supply chain will be achieved by making the results of research freely available in the public domain through effective publication and dissemination taking account of any commercial or security considerations.

Communications Plan

The strategy will be made available to stakeholders on the NDA's external website.

The challenges associated with the NDA decommissioning mission will be communicated to stakeholders, including universities, through a Technical Baseline report that will outline technical development requirements across the NDA estate.

We will use our membership of various organisations and involvement with various fora (e.g. Next Generation Nuclear CDT) to inform universities about our specific R&D needs, and ensure that this information remains relevant via the NWDRF Working Group on University Interactions.

Communications bulletins summarising past and present university interactions will be produced and disseminated as appropriate.