

Uranics

Credible Options Summary (Gate A)

January 2014

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Executive Summary

The NDA owns a range of materials containing uranium (termed **uranics**) arising from historic or current nuclear fuel cycle operations. The uranics comprise a wide variety of types all stored safely and securely on a number of NDA sites.

The Energy Act (2004) requires the NDA to have a strategy to safely and securely manage uranics in the most practical and cost effective way.

In line with our Strategy Management System, we are assessing the high level credible options for the management of the uranics which are: continued storage, recycle, or disposal. Our assessment is considering the options against a number of criteria such as cost, safety, security, environment and socio-economics, as defined in our Value Framework. Given the variety of types of uranics, we anticipate that no single strategic option will be suitable for the entire uranics inventory.

Civil nuclear materials are not deemed to be waste: at this time, the NDA holds its uranics at a nil value pending development of long-term options and cost estimates. In the future, our assessment may ascribe a value or a liability to each type of uranic material. The dividing line between value and liability is likely to be sensitive to external commercial factors such as the future price of freshly mined natural uranium and may change markedly with time. This may mean that we choose to continue to store some types of uranic materials for an extended period pending a future decision on whether to dispose of them or realise a commercial value through reuse.

As part of the process leading to decisions on how to manage our uranic materials we will, as appropriate, discuss the credible options with regulators, Government departments, local communities and other interested parties.

This paper has been published to inform stakeholders. There is no formal period of engagement, although we welcome comments from interested parties and we can be contacted by e-mailing strategy@nda.gov.uk.

1 Background

1.1 Origin

'Uranics' are materials containing uranium which have been produced from fuel cycle operations such as enrichment, fuel fabrication and reprocessing since the 1950's.

There is a significant stockpile of uranic material, held at several NDA sites. Some of this material is owned by customers of the NDA, mainly domestic and overseas utilities, who have reprocessing or storage contracts with NDA. The majority is owned by the NDA. Uranics owned by our customers are managed under the terms of their contracts. These contracts are managed by International Nuclear Services (INS).

In addition to uranics on our sites, other sites in the UK hold stocks of uranium containing materials. These stocks are not owned by NDA and are not considered further in this paper.

1.2 UK Policy Context

The Energy Act (2004) requires the NDA to have a strategy to safely and securely manage uranics in the most practical and cost effective way. Uranium is a nuclear material, and specifically is not classed as a waste as all uranics have the potential, subject to the availability of the appropriate power stations and supporting infrastructure, to be used as nuclear fuel generating significant quantities of electricity. The NDA's uranics are held at nil value pending development of long-term options and cost estimates. As such, any Government policy on waste management does not apply to uranics, but will apply to any wastes that may arise during handling, processing or storage.

While the uranics stocks are held as a strategic reserve because of their potential energy value, if it were decided at some point that they had no further use, they may need to be managed through disposal. The UK Government will decide, in conjunction with NDA and the other uranics owners, whether or not any of the uranics stocks in the UK should be declared as waste. In the meantime the NDA will factor possible inclusion of all these materials into the design and development of the geological disposal facility¹.

1.3 Strategic Objective

The principal objective in our Strategy² is to ensure safe, secure management of our uranics inventory while continuing to provide best value for the UK taxpayer. In order

¹ Managing Radioactive Waste Safely, White Paper, June 2008.
<http://www.official-documents.gov.uk/document/cm73/7386/7386.pdf>

² NDA Strategy, April 2011

to do this we are committed to utilising our existing infrastructure and contract arrangements to manage our uranics in a cost-effective manner and to fostering collaboration between our sites and international entities to ensure continued application of best practice.

The current uranics management practices on our sites meet this objective. However, all the sites where the material is located have defined end-states and so their uranics management plans are valid only as long as operations continue on those sites. We therefore need to develop an end point for our uranics which is consistent with the end points of the sites. In effect, this means for a particular type of uranic we need to be able to either return it to the fuel cycle, for reuse in reactors, or convert it into a disposable waste form and dispose of it, recognising that relocation to an alternative site for continued storage may be a viable option in the medium term.

1.4 Inventory and Location

This paper considers the NDA's inventory of uranics and excludes uranics belonging to other organisations. The bulk of NDA's uranic materials under consideration in this paper fit into one of the following material categories:

- Uranium Hexafluoride tails (UF₆ tails, also known as "Hex")
- Magnox Depleted Uranium (MDU), as Uranium Trioxide, UO₃
- THORP Product Uranium (TPU), as UO₃
- Uranium Tetrafluoride (UF₄)
- Uranium in other forms and of various enrichments

As well as UF₆, UO₃ and UF₄, the uranics inventory is in several different forms, including uranium dioxide, metal, carbide, residues, powder and pellets and is currently located at Capenhurst, Dounreay, Harwell, Springfields, Sellafield and Winfrith.

A summary of the NDA uranics inventory is presented in Table 1. The stock of uranic material frequently changes on sites such as Springfields, Capenhurst and Sellafield where there are ongoing business activities. The UK holdings of uranics (which include materials owned by NDA as well as other UK-based organisations) are summarised in the following link [³].

³ <http://www.nda.gov.uk/ukinventory/documents/Reports/upload/Radioactive-Materials-Not-Reported-in-the-2010-UK-Radioactive-Waste-Inventory.pdf>

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Uranic Material	NDA stock (teU)
UF ₆ tails	~21500
MDU	~26000
TPU	~300
UF ₄	~230
Other forms or uranium:	
Depleted	~400
Natural	~300
Low enriched	~120
High enriched	~1

Table 1: High-level Summary of the NDA Uranics Inventory
Note uranium contained in residues is included in the above figures

For the purposes of this paper, the NDA's HEU inventory is considered in the exotics fuels strategic theme^{4,5} and will not be discussed further in this report.

The Capenhurst Inventory

The bulk of the inventory is stored at Capenhurst. There are approximately 26,000 teU of MDU and 20,500 teU of UF₆ tails. There are an additional 230 teU of UF₄, around 4.5 teU of low enriched uranium (LEU) in 15 te of residues, and around 1.25 teU as low enriched uranium (dissolved in hex cylinder washings).

There is also an amount of uranics material stored and managed on behalf of MoD (comprising metal, MDU and UF₆ tails), and an additional quantity of MDU which is owned by overseas utilities. Other future arisings will comprise a further ~2,600 teU of NDA-owned MDU from future Magnox reprocessing.

The URENCO-owned site adjacent to the NDA Capenhurst site also holds URENCO's stock of UF₆ tails which is increasing as enrichment activities continue. URENCO are constructing a facility at Capenhurst to deconvert UF₆ tails to U₃O₈ which is a more stable form for storage.

We are committed to reduce the potential hazard associated with continued hex storage. Through a commercial agreement with Capenhurst Nuclear Services Ltd., part of the URENCO group of companies, we have secured a way of transferring our

⁴ <http://www.nda.gov.uk/documents/upload/Exotic-Fuels-and-Nuclear-Materials-Dounreay-Credible-Options-February-2012.pdf>

⁵ <http://www.nda.gov.uk/news/harwell-credible-preferred-options.cfm>

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UF₆ tails into modern containers prior to deconversion in the new URENCO-owned facility to reduce its potential hazard. We intend to start deconversion by 2020.

The Harwell and Winfrith Inventory

Harwell and Winfrith have ~30 teU of depleted, natural and low enriched uranium (LEU) as metal and oxide. A small quantity of the LEU is enriched between 5-10%.

The Dounreay Inventory

Dounreay has an inventory of uranic materials which comprises LEU (metal, oxide, UF₄, total circa 0.3 teU), natural (carbide, metal and oxide, total circa 7.3 teU) and depleted (carbide, metal, oxide, UF₄, uranyl nitrate liquor, total circa 22 teU). A proportion of the LEU at Dounreay is enriched between 5-19.9%. We plan to process the uranium carbide into a more stable form which is better suited to storage.

The Springfields Inventory

Springfields holds ~900 teU as UF₆ tails, and a further ~800 teU of varying enrichments as metal, U₃O₈, UO₃, UO₂ and residues (graphite, cutting oil etc.). The quantity is constantly changing through processing operations.

Springfields has recently received for characterisation and processing ~57 teU of natural uranium as metal and oxide and ~8 teU of depleted uranium as metal and oxide from Harwell and Winfrith.

The Sellafield and Windscale Inventory

Sellafield and Windscale have an inventory of uranic material in the main comprising UO₃ owned by UK and foreign utilities. This UO₃ is stored and managed under contract and is intended to be returned to the customer, in line with any commercial agreements and customer requirements. There are ~300 teU of NDA-owned TPU. In addition, there are ~15 teU of depleted and natural uranium as UO₂ pellets and metal mostly remaining from commissioning of the reprocessing plants.

2 Credible Options

2.1 Options Assessment

In line with our Strategy Management System, we are assessing the high level credible options for the management of the uranics.

Civil nuclear materials are not deemed to be waste: at this time, the NDA holds its uranics at a nil value pending development of long-term options and cost estimates. The current approach for the management of NDA's uranic materials is therefore to store them in their current form or where necessary to reduce their intrinsic chemical hazard, repackage and consolidate them into a form more suitable for ongoing storage.

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As previously mentioned, customer-owned material is managed in line with the applicable commercial agreements and customer requirements. The management options adopted by our customers are essentially the same as those available for our own stocks. We are considering opportunities for realising synergistic benefits through the co-management of customers' and our uraniums.

2.2 Management Options

We believe the future management options, at a high level for all categories of uranium material, are:

- Continued Storage
- Recycle
- Disposal

These management options are discussed in more detail below.

Continued Storage

The physical and chemical form in which the bulk of the materials are presently stored is not expected to change during storage over the next 20 to 30 years such that a change of strategy will be required. Our site operators are required to maintain the assets used to store our uranium materials including the storage buildings and containers. The maintenance regime includes regular inspections to ensure the packaging meets the required containment standards and to identify potential degradation mechanisms in advance. Repacking into more durable containers, such as stainless steel drums, has been successful in maintaining safe and secure storage to date and is a straightforward operation which can, if necessary, be adopted in future.

Some of the inventory may be processed to improve the storage containment and/or produce a chemically more stable material, a key example being the deconversion of UF_6 to U_3O_8 at Capenhurst. As mentioned earlier, relocation to an alternative site for continued storage may be a viable option, an example being the transfer of material from Winfrith to Springfields.

Recycle

Recycle of uraniums into the nuclear fuel cycle depends on the availability of suitable processing facilities. While there are a number of facilities both in the UK and overseas which are licensed to process clean uranium materials, facilities which can handle reprocessed uranium (such as MDA and TPU) are few in number and are located overseas at present.

In the short term, recycle of the uraniums into the nuclear fuel cycle is driven by the prevailing conditions in the uranium market. At times when natural uranium, conversion, enrichment and fabrication prices are low, utilities can cost-effectively supply fuel to their reactors from freshly-mined uranium. When these prices are high, utilities seek value from their own, or from others', stocks of uranium, notably



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reprocessed uranium, and in so doing they avoid future costs of ownership such as storage. The attractiveness to a utility of these “secondary” sources of uranium is largely determined by their level of enrichment in the U235 isotope: enriched uranium generally has value when compared with fresh natural uranium while depleted uranium does not. This general balance may be altered depending on the relative costs of natural uranium and enrichment. The market prices can vary significantly over short periods (e.g. following the 2011 earthquake and tsunami in Japan, prices generally fell quite quickly driven by a fall in demand from Japan). Consequently the realisable value of the NDA’s uranium inventory depends on its enrichment and the ability to offer it to the market on any particular timescale.

Several of NDA’s utility customers have recycled TPU back into the fuel cycle using processing facilities in Russia.

NDA has started to evaluate potential markets and assess the near-term value of the uranium inventory across the NDA estate. A limited number of opportunities have been identified and these are being pursued.

Disposal

Although uranium is not classified as a waste some parts of the uranium inventory may be declared as waste if it were decided at some point that they had no further use⁶.

The NDA is factoring in the possible inclusion of uranium into the design and development of the geological disposal facility (GDF). The ultimate disposal route for these materials has yet to be developed. Moreover, the case for whether large volumes of uranium should be committed to the GDF has not yet been evaluated. Disposal in an alternative manner could be preferable.

However, in line with Government policy and in order to inform wider decision-making on the management of UK DNLEU, NDA RWMD established in 2012 a long-term integrated project team (IPT) on depleted, natural and low-enriched uranium (DNLEU), focusing on the disposability and associated full lifecycle implications of managing the UK inventory of these materials through geological disposal in the UK.

The work of the IPT is being carried out in two phases:

Phase 1, completed in March 2013, established the strategic framework for the project and collated current understanding to identify knowledge gaps and uncertainties, considering both issues relating to the UK inventory and management practices in other countries. To conclude this phase the IPT developed a prioritised programme of work to address the knowledge gaps and advance understanding.

⁶ Managing Radioactive Waste Safely, White Paper, June 2008.
<http://www.official-documents.gov.uk/document/cm73/7386/7386.pdf>

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Phase 2, started in January 2013, implements the programme of technical work developed during Phase 1. The technical work areas are as follows:

1. The inventory, the chemical and physical form when packaged for disposal, associated upstream waste processing issues and the full lifecycle implications of disposal concepts.
2. Packaging and disposal concepts from conception through identification and evaluation of credible options to the selection of a range of preferred geological disposal concept options and the development of associated generic package specifications.
3. Transport, operational and post-closure safety assessments. Post-closure safety is a key issue for the IPT because the long half-life of U-238 and the radiological hazard associated with its daughter products have the potential to lead to calculated risks that exceed the regulatory risk guidance level in the very far future.
4. Research and data gathering to ensure that the strategies and options formulated elsewhere in the IPT are informed by up-to-date scientific knowledge of uranium and, where safety-relevant uncertainties exist, that they are addressed via targeted research.
5. Technical integration and review of work across the four other work areas, to provide opportunities for interaction with internal and external stakeholders, and to demonstrate how the Phase 2 work advances overall technical understanding of the geological disposal of DNLEU.

All of the technical work will progress through four gated stages:

1. Methodology development (FY 2012/13),
2. Identification of credible disposal concepts (FY 2013/14),
3. Assessments to inform options refinement (FY 2014/15), and
4. Identification of preferred options (FY 2015/16).

3 Next steps - Timeframe and stakeholder engagement

Until such time as we have reached a strategic decision, we will continue to store the inventory of uranium safely and securely as a strategic reserve, repackaging, relocating and processing them where necessary. We aim to maximise the value of our uranium by selling parts of the inventory if it is cost effective and when market conditions are favourable.

In the future, our assessment may ascribe a value or a liability to each type of uranium material. The dividing line between value and liability is likely to be sensitive to external commercial factors such as the future price of freshly mined natural uranium and may change markedly with time. This may mean that we choose to continue to store some types of uranium materials for an extended period pending a future decision on whether to dispose of them or realise a commercial value through reuse. If, however, for some uranium materials we can foresee no further use then we will sentence and subsequently treat this material as waste.



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We are at the early stages of our work, and some of the data will continue to be unavailable for commercial reasons. Our assessment is considering the options against a number of criteria such as cost, safety, security, environment and socio-economics, as defined in our Value Framework⁷. We have not yet reached our preferred options position, an analysis against the Value Framework will be detailed at a later date. Given the variety of types of uranium, we anticipate that no single strategic option will be suitable for the entire uranium inventory.

When we have enough information to make a strategic decision for a particular class of material, we will discuss the options with any affected stakeholders before taking a decision.

4 Summary and Conclusions

There are many different forms of uranium currently stored safely and securely on a number of NDA sites. The bulk of the NDA's uranium inventory is stored at Capenhurst.

The Energy Act (2004) requires us to have a strategy to safely and securely manage uranium in the most practical and cost effective way.

We are assessing the high level credible options for the management of the uranium which are: continued storage, recycle, or disposal. Our assessment is considering the options against a number of criteria as defined in our Value Framework. Given the variety of types of uranium, we anticipate that no single strategic option will be suitable for the entire uranium inventory.

Civil nuclear materials are not deemed to be waste: at this time, the NDA holds its uranium at a nil value pending development of long-term options and cost estimates. In the future, our assessment may ascribe a value or a liability to each type of uranium material. Any potential value is sensitive to external commercial factors and may change markedly with time. This may mean that we choose to continue to store some types of uranium materials for an extended period pending a future decision on whether to dispose of them or realise a commercial value.

As part of the process leading to decisions on how to manage our uranium materials we will discuss the credible options with regulators, Government departments, local communities and other interested parties.

This paper has been published to inform stakeholders. There is no formal period of engagement, although we welcome comments from interested parties and we can be contacted by e-mailing strategy@nda.gov.uk.

⁷ <http://www.nda.gov.uk/stakeholders/newsletter/value-framework.cfm>