Nuclear Decommissioning Authority

Integrated Waste Management

Radioactive Waste Strategy

July 2018

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Executive Summary

In the 2016 NDA Strategy we made a commitment to develop a single radioactive waste strategy for the NDA Group. This strategy applies to all radioactive waste generated within the NDA estate, (including materials that may become waste at some point in the future). The radioactive waste strategy provides a high level framework within which waste management decisions can be taken flexibly, to ensure safe, environmentally acceptable and cost-effective solutions that reflect the nature of the radioactive waste concerned.

A single radioactive waste strategy provides a consolidated position and greater clarity of our strategic needs in this area; promotes cross-category waste management opportunities; supports a risk-based approach to waste management and provides an integrated programme to deliver suitable and timely waste management infrastructure to support the NDA mission.

The strategy articulates our strategic positions and preferences against each of the waste management lifecycle stages:

- planning and preparation
- treatment and packaging
- storage
- disposal

To implement this strategy we will create an integrated programme which will build upon the success of the Low Level Waste (LLW) programme. The integrated programme will seek to drive changes in waste management behaviour and culture to allow waste producers to flexibly and effectively manage their radioactive waste as well as develop proportionate waste management solutions.

The programme will be implemented in prioritised phases with the initial focus on areas such as wastes at the LLW/ILW boundary, waste management culture and packaging. This will deliver benefits through the provision of a more integrated approach to radioactive waste management; development of proportionate, risk based waste management approaches; better coordination across the industry and reduced lifecycle costs.

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1. Introduction

1.1 Background

The UK has been producing and managing radioactive waste for many decades. The NDA's role is to ensure that the UK's nuclear legacy sites are decommissioned and cleaned up safely, securely, cost-effectively and in ways that protect people and the environment, across 17 NDA-owned sites in England, Wales and Scotland.

Nuclear site operations and successful site decommissioning and remediation depend on the availability of a robust, sustainable waste management infrastructure. Effective and optimised waste management is an essential requirement for the delivery of our mission and is a significant part of our programme [1].

Over 90% of the UK Radioactive Waste Inventory by volume is generated by the NDA estate, covering the full spectrum of wastes contaminated or activated by radioactivity from Very Low Level Wastes (VLLW), Low Level Wastes (LLW), Intermediate Level Wastes (ILW) to High Level Wastes (HLW). Whilst primarily an NDA strategy, this document will also be of interest to other producers of radioactive wastes, radioactive waste management facility operators, suppliers of waste management services, regulators, local planning authorities and communities where radioactive wastes are generated and/or managed.

2. Radioactive Waste Strategy

2.1 Scope of the Strategy

The 2016 NDA Strategy identified that an integrated approach to radioactive waste management would provide greater opportunities for optimisation, especially for those wastes at the classification boundaries of ILW/LLW and LLW/VLLW; it highlighted a lifecycle approach to waste strategy that involves the following key steps:

- planning and preparation
- treatment and packaging
- storage
- disposal

In the 2016 NDA Strategy we made a commitment to develop a single radioactive waste strategy for the NDA Group which applies to all radioactive waste generated within the NDA estate, (including materials that may become waste at some point in the future). This strategy does not directly address

effluents and discharges covered by the UK Discharges Strategy [2] or non-radioactive wastes.

The ability to effectively manage radioactive waste is essential to the delivery of the NDA mission and is a key enabler to the NDA's strategic themes: Site Decommissioning and Remediation, Spent Fuel Management and Nuclear Materials and Integrated Waste Management. This radioactive waste strategy document provides a high level framework within which waste management decisions can be taken flexibly, to ensure safe, environmentally acceptable and cost-effective solutions that reflect the nature of the radioactive waste concerned.

This radioactive waste strategy aligns with our overarching Integrated Waste Management principles and informs the development and implementation of all topic strategies within the NDA Integrated Waste Management Theme:

- supporting key risk and hazard reduction initiatives by enabling a flexible approach to long-term waste management
- taking into consideration the entire waste management lifecycle, including how waste management is needed to support other NDA strategic or wider UK initiatives such as large-scale decommissioning programmes
- applying the waste hierarchy which is recognised as good practice and should be used as a framework for waste management decision-making, enabling an effective balance of priorities including value for money, affordability, technical maturity, and the protection of health, safety and the environment
- promoting timely characterisation and segregation of waste, which delivers effective waste management
- where appropriate, provide leadership by encouraging greater integration across the estate and supply chain, in particular by seeking opportunities to share treatment and interim storage assets, capabilities and learning
- supporting and promoting the use of robust decision-making processes to identify the most advantageous options for waste management
- enabling the availability of sustainable, robust infrastructure for continued operations, hazard reduction and decommissioning

Whilst this is primarily an NDA strategy, we do have obligations to make our waste management infrastructure available to the wider nuclear industry where appropriate, e.g. access to LLW management services, Higher Activity Waste (HAW) disposability advice and providing a route for HAW sealed sources where the use of our infrastructure would be the most optimum route. We have also provided a waste treatment service for other UK radioactive waste producers and we will continue to investigate opportunities in this area

where it can be demonstrated that this is the best option and is of overall value to the taxpayer.

2.2 Objectives

The key objectives of this strategy are:

- application of the waste hierarchy where it is practicable and appropriate to do so recognising that hazard and risk reduction and nuclear safety priorities may limit application of the waste hierarchy in certain circumstances
- provide a robust, sustainable waste management infrastructure, essential to the safe, effective delivery of the NDA mission, making best use of existing waste management assets and developing new fit for purpose waste management routes as required
- the waste management infrastructure needs to be flexible and be able to facilitate prompt decommissioning and remediation of facilities and sites where appropriate
- risk-based waste management with greater emphasis placed on the nature of the waste rather than classification to aid in identifying the most appropriate waste management route
- enable a lifecycle approach to the management of radioactive wastes which will help identify the most appropriate waste management route determined by the risk posed by the waste
- make radioactive waste ultimately disposable in a manner that protects people and the environment
- consider materials that may become waste in the future and to understand the implications of such scenarios on both the existing waste infrastructure and the requirements, timing and need for new waste infrastructure
- drive/facilitate changes in waste management behaviours and culture to encourage waste producers to consider all stages in the waste hierarchy

2.3 Benefits

A single strategic approach to radioactive waste management will deliver benefits, particularly in the area of waste management optimisation.

Key benefits of the development of a radioactive waste strategy are:

- optimisation: a single strategy will provide greater opportunities to optimise the management of wastes by the risk posed by those wastes resulting in reduced costs and schedules

- clarity: clear articulation of our strategic requirements for radioactive wastes in a single document
- implementation: provides the mechanism for an integrated waste management programme, reducing duplication of effort
- infrastructure: opportunities to develop a robust, sustainable waste management infrastructure at the most appropriate time

2.4 Interfaces with current strategies

This strategy is developed from the UK Strategy for the Management of Solid Low Level Waste from the Nuclear Industry [3] and the NDA Higher Activity Waste Strategy [4]. The UK LLW strategy is published by government and reviewed approximately every 5 years. Key themes and strategic objectives are captured within this strategy. However, the UK LLW strategy will always be the overarching strategic document for the management of LLW. The NDA Higher Activity Waste Strategy was published in May 2016 and articulated the HAW strategy for the NDA estate. Within the NDA HAW strategy were a number of specific positions with regard to supporting risk and hazard reduction from the Sellafield legacy facilities through the use of containerisation of raw wastes. This is summarised in Appendix 2.

3. The Radioactive Waste Management Lifecycle

The management of all classifications of radioactive wastes involves a number of key stages:

- planning and preparation
- treatment and packaging
- storage and disposal

These key stages are expanded and shown in greater detail in Figure 1.

Figure 1: Radioactive Waste Management Lifecycle

3.1 Planning & Preparation

Planning and preparation is essential for successful waste management and is an ongoing, iterative process for all stages of the waste management lifecycle. We expect our Site Licence Companies (SLCs) to identify and implement opportunities for managing wastes and materials that may become waste in the future as soon as reasonably practicable in accordance with the principles detailed above. Opportunities identified early on will continue to accrue benefits throughout the lifecycle.

Understanding the inventory of waste and materials that need to be managed throughout the decommissioning and waste management processes is essential to successful planning and preparation. The NDA manages the production of the UK Radioactive Waste Inventory (UKRWI) [5] on behalf of government. This inventory provides the best available information on all categories of radioactive wastes and materials in the United Kingdom.

The UKRWI is a key data set used by a wide range of stakeholders to:

- inform waste management strategies and plans
- support communications with key internal and external stakeholders
- assist the UK in meeting international reporting obligations

It is essential that data used to compile the inventory is credible, collected in a consistent and efficient manner and presented appropriately to meet stakeholder needs. We will continue to work with government, regulators and the nuclear industry to identify and implement areas for improvement. The development of the inventory is supported by the National Inventory Forum, (NIF) whose primary objectives are to:

- improve the efficiency of data collection for the inventory and related programmes of work
- understand stakeholder needs
- identify areas of improvement, prioritise improvement activities and support implementation
- establish and maintain a community and forum for sharing best practice in the field of radioactive waste (and materials) inventory data compilation, management and communication

Characterisation plays an important role in the decommissioning of nuclear facilities; forming the basis for planning, identification of the extent and nature of contamination, assessment of potential risk impacts, cost estimation, implementation of decommissioning and waste management, radiation protection, protection of the environment as well as supporting decisions to release buildings and sites.

In recognition of the importance of characterisation to the management of radioactive wastes, and based on feedback from our Site Licence Companies and regulators, we are leading the production of a characterisation guidance document to detail the principles, processes and practices that should be undertaken when characterising solid radioactive wastes. It is important to note that characterisation is not restricted to radiological aspects of the waste. An understanding of non-radioactive characteristics such as chemotoxic and hazardous components is essential to support waste treatment and disposal decision making criteria.

We also require our sites to produce Integrated Waste Management Strategies (IWS) which describe:

- how waste producers optimise their approach to waste management
- the wastes they expect to generate during the lifetime of the site
- actions required to improve their approach to waste management

These IWS documents ensure that stakeholders are aware of waste management plans. They demonstrate that the capability and capacity exists to manage all wastes or identify gaps and the actions needed to address them. We will continue to work with our SLCs and regulators to ensure that our guidance and specification for IWS is fit for purpose via regular reviews and revisions. As part of the Guidance on Requirements for Release of Nuclear Sites from Radioactive Substances Regulation (GRR) [6], sites are also required to produce a site-wide environmental safety case which is supported by the production of a comprehensive waste management plan. We will work with regulators and our SLCs to ensure that these plans are complementary and do not duplicate the work required by our SLCs.

3.2 Treatment and Packaging

The aim of waste treatment and packaging is to process raw waste into a form that is suitable for disposal, where routes are readily available, or for long-term storage pending the development of suitable disposal routes. Typically, this process will cover a number of steps and employ a range of technologies including:

- retrieval of waste: the safe removal of waste from temporary storage facilities or legacy storage facilities for further management and/or the direct generation of waste from operation/decommissioning activities. In some circumstances it may not be possible to remove the entire inventory and SLCs may consider alternative options for residual waste including *in situ* treatment or disposal to support decommissioning and site remediation activities
- sorting and segregation: an activity where types of waste or material are separated or are kept separate, on the basis of radiological, chemical and/or physical properties, to facilitate waste handling and/or processing
- size reduction: a treatment method that decreases the physical size of an item, for example, to meet packaging or treatment requirements or to make subsequent management easier
- decontamination: the removal or reduction of radioactive contamination by a deliberate physical or chemical process to achieve either reclassification of the waste, to meet specific waste management facility acceptance limits or to reduce dose uptake for subsequent operations
- treatment: can comprise thermal/chemical/physical processes and results in the change of the characteristics of the waste. Opportunities to investigate consolidated treatment options between multiple sites could be beneficial and we will work with our SLCs and the wider nuclear industry to identify potential opportunities
- conditioning/immobilisation: changes the form of the waste such that the resulting product can be safely handled, transported, stored and if necessary disposed of

- packaging: the process of loading waste into a container that is suitable for handling, storage (potentially long-term), transport and disposal. The range and types of packaging vary with the type of waste being stored, the activity of the waste and whether the package is intended to provide radiation shielding. Packaging also includes containerisation, which is the emplacement of unencapsulated waste in a suitable container where the reliance on the contribution of the wasteform to the overall performance of the waste package is reduced. Containerisation can offer benefits in terms of acceleration of decommissioning programmes and the removal of the requirement for encapsulation facilities and shielded stores. We will provide leadership in this area to help SLCs make robust decisions on their tactics around waste container selection

3.3 Storage

Storage is defined as the holding of radioactive waste or material in a facility that provides for its containment, with the intention of retrieval. Where waste cannot be disposed of immediately, storage facilities are required across the estate until a disposal route becomes available. This is an essential enabling component of decommissioning. The majority of our stores are for the storage of ILW and we have robust storage arrangements, coupled with a disposability assessment process, to provide confidence that packages will be disposable at the end of the storage period. In line with UK and devolved administration policies and CoRWM recommendations we will ensure that our strategy allows for the safe and secure storage for a period of at least 100 years.

At times it may be necessary or desirable not to foreclose options and to store containerised raw waste in modern interim storage facilities to enable decommissioning or to progress hazard reduction. Such facilities will need to comply with SLC safety procedures and will require an additional treatment step prior to final disposal which may place different demands on the storage system.

We have published storage guidance [7] which covers the key elements of a robust approach to interim storage for HAW. A number of stores have already been constructed across the NDA estate and plans are in place for the construction of stores in the future. Making the best use of existing assets and investigating store consolidation opportunities where they are available have the potential to provide cost and/or schedule benefits. Several examples are being implemented within the NDA estate, for example: Magnox storage consolidation options and the transfer of certain wastes from Harwell to Sellafield for treatment and/or storage.

There are a number of reasons why radioactive waste is stored, and the high-level function for each storage type is highlighted below. In particular for HAW, storage is required until such time that an appropriate treatment or disposal route becomes available, which could include allowance for decay to enable reclassification.

<table>
<tr><th>Storage type</th><th colspan="5">Function</th></tr>
<tr><td>Buffer storage of Raw waste</td><td colspan="5">The short-term storage of waste arisings to allow the management of waste feed to a treatment process. Buffer storage can be used to enable some degree of pre-treatment or homogenisation and/or to control the feed of waste to a subsequent treatment or conditioning process.</td></tr>
<tr><td rowspan="4">Interim storage of waste that is either raw or treated</td><td colspan="2">Treated/conditioned waste</td><td colspan="2">The preferred storage mode for HAW is safe secure storage of waste that has been conditioned and packaged ready for transport and disposal.</td><td>Decay</td></tr>
<tr><td rowspan="3">Raw waste storage</td><td>In situ</td><td>Raw waste storage in-situ could be considered to be waste that has not yet arisen or been generated. This could apply to e.g. some or all of defueled reactors waiting decommissioning, or the use of fixatives to tie down contamination in a pond that has been prepared for future decommissioning.</td><td rowspan="3">Interim storage can enable waste producers to take advantage of radioactive decay or waste evolution</td><td rowspan="3">Taking advantage of radioactive decay to enable a specified retrieval or treatment step, or to allow a change in disposal route. This management step can be expressed as decay storage at the outset of packaging for storage or it can be a management step that is selected after a period of interim storage.</td></tr>
<tr><td>Facility</td><td>Storage of retrieved raw waste in a dedicated facility, such as the silos and vaults commonly seen at reactor sites.</td></tr>
<tr><td>Package</td><td>Storage of retrieved raw waste in a new container. This may be to advance retrievals by decoupling them from subsequent treatment steps, or the packaged raw waste may ultimately be disposable with no further treatment step required.</td></tr>
<tr><td>Buffer storage of packaged waste</td><td colspan="5">The short term storage of packaged waste to allow the management and synchronisation of waste packages being exported from a store and imported into the subsequent storage or disposal facility.</td></tr>
</table>

Table 1: Radioactive Waste Storage

We will continue to work with our SLCs and subsidiaries to ensure that we have a robust and fit-for-purpose storage infrastructure that appropriately supports our decommissioning and waste management mission.

3.4 Disposal

Disposal is the final stage in the waste lifecycle and is the emplacement of waste into an appropriate facility with no intention to retrieve it.

Disposal of radioactive waste should follow a risk-based approach and developers and operators of disposal facilities for solid radioactive waste have to demonstrate that their facilities will properly protect people and the environment. They also need to show that their approach to developing the facilities and the location, design, construction, operation and closure of the facilities meet a series of principles and requirements. These are detailed in two documents:

- Guidance on Requirements for Authorisation of Near-surface Disposal Facilities on Land for Solid Radioactive Wastes [8]
- Geological Disposal Facilities on Land for Solid Radioactive Waste [10]

The timely availability of fit-for-purpose disposal capability is essential to the implementation of the radioactive waste strategy as it enables the NDA to deliver its mission. The current system of waste categorisation and waste disposal does not readily support waste management decisions based on the risk posed by the waste or material. Such an approach, as identified in the 2016 UK LLW Strategy, could provide benefit to the industry by making best use of capacity and capabilities that either exist now or could be developed in the future. We will work with government, regulators and the nuclear industry to determine how this could be optimised.

We have specific obligations to UK government and devolved administrations with respect to disposal. We own the LLWR which is managed by LLW Repository Ltd on our behalf and provides a disposal service to both our estate and the wider UK nuclear industry. We, along with our subsidiary RWM, are responsible for the implementation of policy on management of higher activity radioactive waste through geological disposal [10]. A geological disposal facility (GDF) is a highly engineered facility capable of isolating radioactive waste within multiple protective barriers, deep underground, to ensure that no harmful quantities of radioactivity ever reach the surface environment. Radioactive waste management is a devolved policy issue and Welsh Government has adopted a policy of geological disposal [11] and Scottish Government HAW policy & its implementation strategy [12], [13] is that long-term management of HAW should be in near-surface facilities.

LLW Repository Ltd also manages the implementation of the UK Nuclear LLW Strategy and a key part of this strategy is the development of alternative waste management routes. This has resulted in the supply chain developing their own landfill sites for the disposal of VLLW and lower activity LLW wastes. The LLW National Programme has been successful in diverting significant volumes of LLW from disposal to the LLWR, typically 85-90%.

On-site disposal is also undertaken by some of our SLCs. Sellafield have an on-site facility capable of accepting some lower activity wastes and DSRL have constructed a LLW repository adjacent to the site to accept LLW from Dounreay and the neighbouring MOD Vulcan Naval Reactor Test Establishment.

Regulatory Guidance	Disposal Capability	Waste Type	Disposal Capability Owner
Near-surface Disposal Facilities on Land for Solid Radioactive Wastes – Guidance on Requirements for Authorisation February 2009	On-site disposal (existing capability)	VLLW/LLW	NDA
	Specified Landfill Disposal (existing capability)	VLLW/LLW	Commercial Landfills
	LLWR/DSRL LLW Facility (existing capability)	LLW	NDA
	HAW Disposal Option in support of Scottish government policy(planned future capability)	ILW	To be determined
	Near-Surface Disposal (England/Wales (potential future capability)	LLW/ILW	To be determined
Geological Disposal Facilities on Land for Solid Radioactive Wastes – Guidance on Requirements for Authorisation February 2009	Geological Disposal Facility (planned future capability)	ILW/HLW & LLW not suitable for disposal by other routes	NDA

Table 2: Current, planned and potential disposal capability

Additionally, there is regulatory guidance under development which articulates the process for releasing a nuclear licensed site from the requirements of

radioactive substances regulation when all activities involving the generation and disposal of radioactive wastes have ceased. (GRR) This guidance discusses a number of scenarios whereby some activity may be managed on site either as *in situ* contamination or as a permitted disposal in dedicated facilities or void filling of existing infrastructure. Where it is appropriate to do so, we will develop on-site and/or *in situ* disposal capability to support the decommissioning and remediation of our sites.

In support of both UK policy, which requires us to review appropriate solutions that could have the potential to improve the long-term management of some of the UK's higher activity radioactive waste, and Scottish HAW Policy, we have initiated a project to investigate strategic options for the near-surface disposal of some of the radioactive waste inventory that does not require the engineering and isolation requirements of a GDF. This could provide an opportunity for an earlier disposal solution, to enable site decommissioning and remediation and, in particular, risk and hazard reduction programmes. Following completion of the project we will make recommendations to government on whether near-surface disposal should form part of the waste management capabilities for England and Wales, recognising that this approach is already Scottish HAW policy position.

Appendix 1 contains a summary of radioactive waste policies in the UK.

4. Summary of Strategic Positions/Preferences

This strategy outlines our strategic positions and preferences for each stage of the waste management lifecycle and these are summarised in the table below:

Lifecycle Stage	Waste Type	Strategic Position/Preference
Planning & Preparation	All waste types	**Integrated Waste Strategies** - All sites will produce an Integrated Waste Strategy describing their approach to optimising waste management for the wastes they expect to generate during the lifetime of the site and the actions required to improve their approach to waste management. We will continue to work with our SLCs and Regulators to ensure that our guidance and specification for IWS is fit for purpose and we will regularly review and revise our guidance.
	All waste types	**Waste Inventory** - It is essential that data used to compile the inventory is credible, collected in a consistent and efficient manner and is presented appropriately to meet stakeholder needs and we will continue to work with Government, Regulators and the industry to identify and implement areas for improvement
	VLLW, LLW & ILW	**Waste Characterisation** - NDA will work with regulators and the industry to develop a Characterisation Good Practice Guide to detail the principles, processes and practices that should be undertaken when characterising solid radioactive wastes
Treatment & Packaging	HLW	**Vitrification –** Highly active liquor from the reprocessing of spent fuel is vitrified and stored pending disposal to the GDF.

Lifecycle Stage	Waste Type	Strategic Position/Preference
	ILW	**Waste Packaging** – We will provide leadership in this area to help our SLCs make robust decisions on their tactics around waste container selection
	ILW	**Near-term Risk Reduction** - At facilities where our immediate priority is near-term risk reduction we will retrieve wastes and provide waste storage (containerisation) arrangements knowing that further waste treatment steps will be necessary prior to disposal
	ILW	**Wet ILW** - Current arisings of Wet ILW are retrieved, conditioned and stored in engineered facilities and subsequently disposed of when a GDF becomes available or long-term management in near-surface facilities for wastes in Scotland. Current Lifetime Plans for the NDA's Scottish sites are being reviewed and updated to take account of Scottish HAW policy. Historical raw wastes and historical packaged wastes will be retrieved from ageing facilities and packaged into a disposable form and transferred to an engineered interim store. The timing of retrievals and waste treatment of the historical wastes is based on the NDA Lifetime Plans. As a contingency all sites must consider the possible impact of a delay in a GDF programme. To help with this contingency planning all new interim stores will have a design life of 100 years or more with appropriate care & maintenance programmes in place. There are unique challenges for some of Sellafield legacy wastes. Command 2919 (1995) states that where safety is overriding then the initial risk reduction processes can be supported. The NDA Strategy; section HAW Delivery – 'At facilities where our immediate priority is near-term risk reduction we are prepared to retrieve wastes and provide waste storage (containerisation) arrangements knowing that further waste treatment steps will be necessary prior to disposal. We will continue to work with RWM and our SLCs to improve this important risk reduction programme at Sellafield.'
	LLW & ILW	**Treatment Framework** – Waste treatment baseline plans are often dominated by cement encapsulation on the basis that it is a tried and tested approach that can deliver an acceptable product, suitable for storage and disposal. Cement encapsulation has an important role to play in the future treatment of radioactive waste. In practice, cement encapsulation can sometimes be more challenging to implement than has been assumed, e.g. it leads to overall waste volume increase, which impacts on subsequent storage and disposal costs and might not represent an optimal solution for wastes with a significantly reactive component. In addition, the nature of the waste arising across the estate is changing as operations progress from support to reprocessing through to treatment of legacy wastes, decommissioning and site remediation. Alternative treatment technologies could offer advantages over the baseline approach, in terms of cost savings, risk reduction, waste product quality, and volume reduction. For this reason NDA is exploring the strategic opportunities. Broadening the available technology options also serves to reduce risk by providing a level of contingency to the baseline treatment position. Work to date has focussed on determining where the main strategic opportunities exist across the NDA estate, with particular attention given to development of thermal treatment technology and a strategic approach to encapsulation.
	VLLW, LLW	**LLW Treatment Services –** Where practicable VLLW and LLW should be treated to reduce the volume of waste requiring disposal. VLLW and LLW have a range of treatment options such as high force compaction, metal decontamination and incineration.
Storage	VLLW, LLW & ILW	**Waste Storage** – We will continue to work with our SLCs to ensure that we have a robust and fit for purpose storage infrastructure that appropriately supports our decommissioning and waste management mission
	ILW	**Current Storage Arrangements** - Individual sites will ensure that their waste storage arrangements meet the current export timescales to a GDF or long-term management in near-surface facilities for wastes in Scotland. As a contingency all sites must consider the possible impact of a delay in the GDF

Lifecycle Stage	Waste Type	Strategic Position/Preference
		programme. To help with this contingency planning all new stores will have a design life of 100 years or more with appropriate care and maintenance plans in place.
Disposal	VLLW, LLW & ILW	**Risk Based Waste Management** – The current system of waste categorisation and waste disposal does not readily support waste management decisions based on the risk posed by the waste or material. The use of a risk based waste management approach, as identified in the 2016 UK LLW Strategy, could provide benefit to the industry by making best use of capacity and capabilities that either exist now or could be developed in the future. We will work with Government, regulators and the nuclear industry to determine how this could be optimised
	VLLW, LLW	**In Situ Disposal –** Where it is appropriate to do so, we will develop on-site and/or *in situ* disposal capability to support the decommissioning and remediation of our sites, following the requirements of the regulators GRR guidance.
	VLLW, LLW & ILW	**Near Surface Disposal –** following the completion of the strategic project we will make recommendations to Government on whether additional near-surface disposal for some HAW should form part of the waste management capability for England and Wales, recognising that this approach is already Scottish HAW policy position.
	HAW	**GDF Implementation –** NDA, along with our subsidiary RWM, will implement the policy on the management of HAW through geological disposal
	Graphite	**Reactor Graphite** - The treatment and disposal of reactor graphite is seen as a key enabler for Magnox decommissioning programme. Before disposal the core reactor graphite will be conditioned into a disposable form and transferred directly to a GDF. Graphite Fuel Element Debris, Pile Graphite and AGR graphite sleeves are also considered as part of this wastestream.
	HLW	**UK Owned HLW –** The current strategy is to convert all the remaining liquid HLW into a vitrified solid which will be stored for at least 50 years and then disposed to the GDF **Overseas Owned HLW** – Sellafield undertakes reprocessing for a number of overseas customers. This material will also be vitrified and the vitrified product will be returned to customers as specified in the reprocessing contracts. In some cases, ILW substitution will be undertaken whereby additional equivalent amounts of HLW vitrified product are returned to customers in lieu of ILW as specified in the reprocessing contracts.

Table 3: Summary of NDA Strategic Positions/Preferences

5. Radioactive Waste Strategy Implementation

The historical position of separate LLW and HAW strategies was not optimised. Implementing this radioactive waste strategy will deliver benefits in the development of proportionate waste management routes for a wider range of waste than currently available. At present there are a limited number of options to deal with radioactive wastes which cannot be managed by existing LLW routes. The implementation of this strategy will enable the development of a broad range and use of most appropriate waste management routes which, in turn, will enable acceleration of the decommissioning programme.

5.1. Programme Approach to Delivery

The UK LLW Policy [14] placed the onus on the NDA to both develop and implement the UK Nuclear LLW strategy on behalf of government. The original LLW strategy was published in 2010 and LLW Repository Ltd were tasked with implementing the strategy on our behalf. To support the implementation, a National LLW Programme was formed, overseen by a programme board comprising senior representatives from LLWR, SLC waste producers and the NDA.

This programme has contributed to the success of the LLW strategy and resulted in:

- driving cultural and behavioural changes within waste producers
- development of a range of alternative waste treatment processes and supporting services
- development of alternative VLLW disposal routes
- diversion of significant volumes of waste from disposal to LLWR, (88%)
- significant cost savings (approximately £150 million between 2009 and 2017)

As a result of the National LLW Programme there is now confidence that the LLWR will continue to have capacity for the duration of the NDA mission. The outcome of the LLW strategy clearly demonstrates the benefit of having aligned policy, strategy and implementation plans.

The radioactive waste strategy provides an opportunity to build upon the change delivered in the LLW environment by applying a similar process and we will create an integrated programme that will evolve over time to deliver this. The integrated programme will seek to drive changes in waste management behaviour and culture to allow waste producers to flexibly and effectively manage their radioactive waste as well as develop proportionate waste management solutions.

The programme will be implemented in phases with the initial focus on areas such as wastes at the LLW/ILW boundary, waste management culture and packaging. This will deliver benefits through:

- the provision of a more integrated approach to radioactive waste management
- development of proportionate, risk based waste management approaches
- better coordination across the industry and reduced lifecycle costs

An initial focus of the programme will be the identification of suitable performance indicators to monitor programme implementation and successes.

5.2 Critical Enablers

There are a number of key critical enablers which directly impact on this strategy and will be crucial to its successful implementation.

5.2.1 People

Execution of the radioactive waste strategy will require people with the appropriate range of skills and knowledge to provide capability across all relevant disciplines involved in the waste management lifecycle. The timing and availability of the required skill sets is vital to the success of this strategy. Radioactive waste management is a long-term venture where inter-generational issues, including skills retention, need to be addressed. In particular, suitably qualified and experienced people will continue to be needed who have a thorough understanding of chemical and waste processing hazards in order to support safe and secure management of radioactive waste. We will work with our SLCs and the nuclear industry to identify key skills and knowledge requirements and develop plans to maintain capability and to manage any gaps.

5.2.2 Information governance

Effective and robust information and knowledge management systems are necessary for the development of strategic opportunities for the implementation of the baseline plan. Furthermore, knowledge retention over very long timescales, such as many decades to a century or more, is an essential consideration.

The ultimate product of radioactive waste management is a waste package and its associated waste package record. The waste package record has to support future operations over the lifetime of the waste package namely interim storage, transport and disposal. The requirements around what information constitutes a waste package record for each step are broadly the same but there are some specific differences and so each lifecycle step must be considered. Plans are already in place to ensure that a robust information governance process is in place and we will work with our SLCs, subsidiaries and regulators to ensure that effective knowledge management systems are maintained.

5.2.3 Transport and logistics

Transport and packaging is an integral part of the waste management lifecycle. The availability of transport routes and associated infrastructure is

an essential part of treatment, storage and disposal especially when dealing with UK-wide or multi-site solutions. At a tactical level, programme logistics will also allow the NDA to optimise its waste export scheduling (the programme for transferring waste from storage to a final disposal facility) with respect to road and rail travel and potentially consideration of sea transport around the UK. We will continue to work with industry and regulators to ensure that transportation, package design and supply are optimised and support the delivery of this strategy.

5.2.4 Research and development

The NDA's radioactive waste management programme needs to be technically underpinned to ensure effective delivery. The implementation of this strategy will require supporting R&D. We will work with our SLCs and the wider R&D community to ensure that necessary R&D is targeted, developed and delivered to support strategy implementation.

5.2.5 International relations

Many other countries face similar waste management challenges. It is important that we learn from the experience of other countries in developing approaches to these activities as this helps us deliver more cost-effective solutions in the UK. We work closely with a number of international committees such as the IAEA and the OECD NEA and also other decommissioning and waste management companies in France, USA and Japan amongst others. We are, through RWM, involved in international collaboration programmes with counterpart organisations in other countries.

There are a number of bilateral agreements with the NDA's overseas counterpart organisations. Under the auspices of these agreements, NDA representatives get together with subject matter experts in those organisations to share and potentially develop joint solutions to the most pressing technical challenges.

We will continue to ensure that international good practice and learning, both technological and sociological, is appropriately reflected in the delivery of our strategy.

6. Waste Management Infrastructure

The implementation and delivery of our strategy depends on having an underpinning delivery programme to facilitate behavioural change in respect of waste management practices ensuring a robust, sustainable waste management infrastructure is developed.

The existing infrastructure comprises a combination of SLC and supply chain-based infrastructure that meets the current needs of the waste producers. The LLW National Programme has been particularly successful in introducing new supply chain waste management routes to support delivery of the UK LLW Strategy and in facilitating changes in waste management behaviour. The National Programme provides governance arrangements that drive programme implementation, a sustainable waste management infrastructure and a platform for sharing best practice and learning from experience to support continuous improvement.

For HAW, much of the infrastructure is located within the NDA estate and the challenge in delivering the radioactive waste strategy will revolve around the best use of these existing and future planned assets and the timely delivery of effective and innovative solutions.

There are limited opportunities to further optimise the management of some of the radioactive waste inventory, particularly HLW and high end ILW. For these streams, the focus is on implementing current baseline waste management options to deliver risk and hazard reduction.

Figure 2 below shows a simplified, high level schematic of existing and planned radioactive waste infrastructure for the NDA estate, excluding specific site level treatment capabilities. Note that the existing LLW management capabilities and the planned GDF are/will be available for all radioactive waste producers.

Appendix 3 includes further details of the LLW framework services and the HAW Waste Treatment Framework.

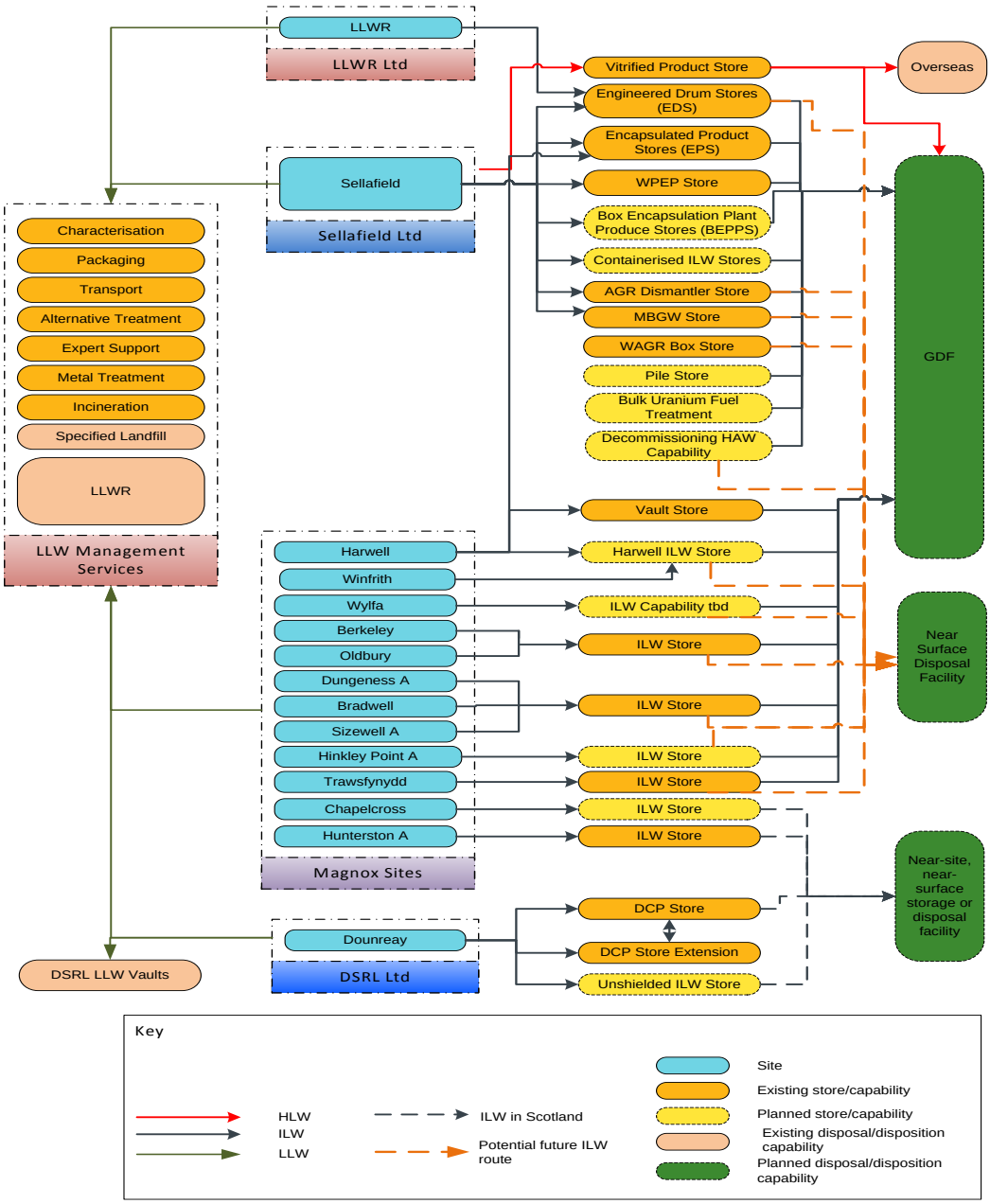

Figure 2: Simplified NDA Radioactive Waste Infrastructure

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Appendix 1 – Supporting Information

A1.1 - Radioactive Waste Policies

Government radioactive waste management policy is supported by a regulatory framework that aims to ensure that the wastes are safely and appropriately managed in ways that pose no unacceptable risks to people and the environment.

Historically, radioactive waste management policy was expressed in the 1995 White Paper 'Review of Radioactive Waste Management Policy, Final Conclusions, Cm2919'. Some aspects of this policy have subsequently been replaced by more recent policy positions to reflect developments in the management of radioactive wastes. This has resulted in policy for radioactive waste management being fragmented across a number of different policy documents.

For HAW, the long-term management policy of the UK government is to package and hold wastes in secure interim storage until they can be transferred to a GDF. This position was developed through the initial Managing Radioactive Waste Safely programme (MRWS), which outlined a framework for implementing geological disposal. This resulted in the publication of the White Paper on Implementing Geological Disposal which sets out the UK government's framework for managing HAW in the long term through geological disposal, recognising that a GDF will be '*implemented alongside ongoing interim storage and supporting research*'. The current planning assumption is that a GDF would be available to receive HAW from around 2040 and HLW and spent fuel in 2075.

The GDF white paper also noted that other long-term management options could emerge as practical alternatives to geological disposal for some wastes in the future and the NDA continues to review appropriate solutions including learning from and engaging with overseas programmes, which could have the potential to improve the management of some of the UK's HAW. (See section 2.6)

The UK policy position recognises that some radioactive materials not currently classified as waste, including spent nuclear fuel, uranium and plutonium, may be managed as HAW if it is decided at some future time they are of no further use. This strategy will apply to these materials from the time that they are declared as waste and will inform management planning and decisions.

The Welsh government has participated in the Managing Radioactive Waste Safely (MRWS) programme since its inception in 2001 and consulted on their

policy for the long-term management of HAW in 2015. It has decided to adopt a policy of geological disposal for the long-term management of HAW. However, this does not mean that a geological disposal facility (GDF) will necessarily be sited in Wales. The Welsh government continues to support the policy of voluntary engagement where potential host communities are able to seek discussions, without prior commitment, about potentially hosting a GDF. The Welsh government considers that a GDF can only be built in Wales if a community is willing to host it.

The Scottish government is not a sponsor of the programme for implementing geological disposal and published its policy on HAW in January 2011. The policy is for long-term management in near-surface facilities. Paragraph 1.19 of the policy states that: *'……Facilities should be located as near to the site where the waste is produced as possible. Developers will need to demonstrate how the facilities will be monitored and how waste packages, or waste, could be retrieved. All long-term waste management options will be subject to robust regulatory requirements.'*

The Scottish government policy addresses disposal solutions, long-term storage and baseline improvement initiatives such as waste processing and storage consolidation opportunities.

LLW policy was consolidated into a single policy document, 'The policy for the long term management of solid low level radioactive waste in the UK, March 2007. This policy was produced recognising that the existing policy at that time was not written with large scale nuclear decommissioning and remediation in mind and the policy provided greater flexibility in managing radioactive waste and established a set of principles:

- The use of a risk-informed approach to ensure safety and protection of the environment
- The minimisation of waste arisings (both activity and volume)
- The consideration of all practicable options for the management of LLW
- A presumption towards early solutions to waste management
- The appropriate consideration of the proximity principle and waste transport issues
- In the case of long-term storage or disposal facilities, consideration of the potential effects of future climate change.

This policy also set out a number of requirements for the NDA, including the development and implementation of a UK nuclear industry LLW strategy, developing a plan for the optimum use of the LLWR and to make NDA-owned LLW management facilities available to other nuclear and non-nuclear managers of radioactive waste where it is practicable to do so.

Following the introduction of the LLW policy, the UK Nuclear Industry Solid Low Level Waste Strategy was published in August 2010. This strategy dramatically changed the LLW management environment and has resulted in a significant diversion of LLW from disposal to the LLWR. This has been achieved through the development and use of alternative treatment and disposal routes, the application of the waste hierarchy, identification and sharing of good practice for LLW management, engagement of a broad group of stakeholders, collaborative working between industry organisations and the introduction of a National LLW Programme managed by LLW Repository Ltd to coordinate the implementation of the UK nuclear industry LLW Strategy.

The 2010 nuclear industry LLW Strategy was reviewed, updated and reissued in February 2016 to reflect the changes and maturity of the LLW strategy. However, the key themes, application of the waste hierarchy, making best use of existing assets and development of alternative waste management routes remain unchanged.

The Council Directive 2011/70/EURATOM requires European Union (EU) member states to have national programmes that ensure the safe management of spent nuclear fuel (SNF) and radioactive waste from civilian activities both now and in the future. The Directive also requires member states to submit progress reports on the implementation of the national programme every three years. The national programme has been developed and is expected to remain largely unchanged, with updates expected every three years.

Figure A1.1 below details the waste management policy framework.

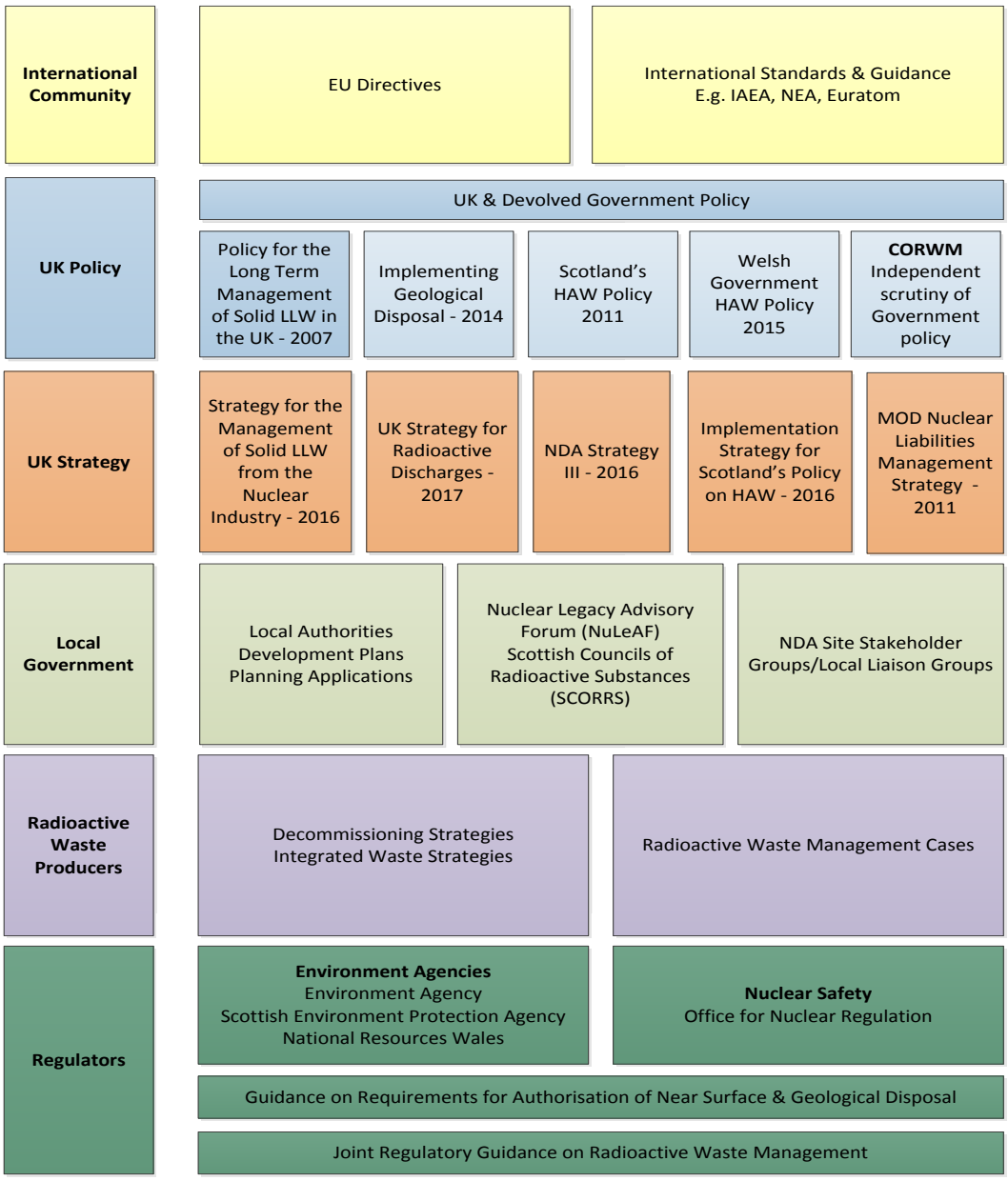

Figure A1.1: Radioactive Waste Management Policy Framework

A1.2 - Radioactive Waste Inventory

The UK has been producing and managing radioactive waste for many decades. The NDA's role is to ensure that the UK's nuclear legacy sites are decommissioned and cleaned up safely, securely, cost-effectively and in ways that protect people and the environment. This covers 17 sites across England, Wales and Scotland. We are also responsible for the

implementation of geological disposal and the UK nuclear industry's Solid Low Level Radioactive Waste Strategy.

Nuclear site operations and successful site decommissioning and remediation depend on the availability of a robust, sustainable waste management infrastructure. Effective and optimised waste management is an essential requirement for the delivery of our mission and is a significant part of our programme.

Radioactive wastes cover the full spectrum of wastes contaminated or activated by radioactivity from Very Low Level Wastes, (VLLW), Low Level Wastes, (LLW), Intermediate Level Wastes, (ILW) to High Level Wastes, (HLW). Detailed strategies for the management of these waste classifications exist and there are significant synergies and overlap in the waste management principles for managing these wastes. This document articulates our strategy for the management of all radioactive wastes within the NDA estate.

This strategy will also be of interest to other producers of radioactive wastes, radioactive waste management facility operators, suppliers of waste management services, regulators, local planning authorities and communities where radioactive wastes are generated and/or managed.

In the UK, radioactive wastes are classified in terms of the nature and quantity of radioactivity they contain and the heat they produce.

High Level Waste (HLW) - waste in which the temperature may rise significantly as a result of its radioactivity, so this factor has to be taken into account in the design of storage or disposal facilities.

Intermediate Level Waste (ILW) - waste exceeding the upper boundaries for LLW that does not generate sufficient heat for this to be taken into account in the design of storage or disposal facilities.

Low Level Waste (LLW) - waste having a radioactive content not exceeding 4 Gigabecquerels per tonne of alpha activity, or 12 Gigabecquerels per tonne of beta/gamma activity.

Very Low Level Waste (VLLW) - a sub-category of LLW, comprising waste that can be safely disposed of with municipal, commercial or industrial waste, or can be disposed of to specified landfill sites subject to limits on radioactivity content.

Radioactive wastes can also be categorised as:

Higher Activity Waste (HAW) - comprises HLW, ILW and a small fraction of LLW (<13,500 m^3 packaged volume) with a concentration of specific radionuclides that prohibits its disposal at existing disposal facilities for LLW.

Lower Activity Waste (LAW) - comprises LLW and VLLW.

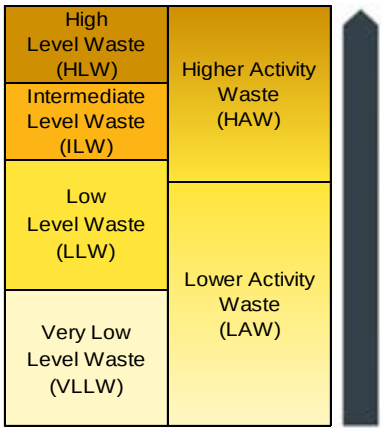

Figure A1.2: Radioactive Waste Categories

Some radioactive materials that are not currently classified as waste would need to be managed as waste if it was decided at some future time they had no further use and would be managed as waste. These materials include spent nuclear fuel, uranium and plutonium.

Radioactive wastes are produced by a number of organisations both within the NDA estate and also by SLCs, Ministry of Defence, industry, hospitals, educational and research establishments, although the latter tend to produce only small volumes of radioactive wastes.

Further details on Radioactive Waste are available at the online UKRWI website: https://ukinventory.nda.gov.uk/

Appendix 2 – Sellafield Legacy Ponds and Silos

Prior to the establishment of industry-wide modern standards for waste processing and storage facilities to enable the conversion of wastes to a passive safe and disposable form, a large amount of ILW was produced and consigned in raw form to a variety of ponds, tanks, silos and other storage facilities. At Sellafield, the legacy ponds and silos storage facilities date from the late 1940s onwards when national imperatives were very different to those of today. These facilities were not designed with consideration of long-term issues such as evolution of the wastes, retrieval, facility decommissioning or the ultimate fate of the waste. Wastes were poorly segregated and full inventory records, which are now recognised as an important requirement for waste management, were not captured to the standard which would be required today. These facilities are not suitable for longer-term interim storage of wastes.

The approach nowadays is very different. We expect Sellafield Ltd and other holders of legacy wastes to work closely with RWM to reduce near-term hazards and, where possible, produce largely passive products by conditioning them promptly into a form suitable for interim storage and ultimate disposal. This is being achieved through waste retrieval, waste treatment and effective conditioning, while applying modern standards with regard to safety, environmental, key stakeholder and cost factors for new facilities.

There is a pressing need to retrieve wastes from a number of our legacy waste management facilities at Sellafield and this is highlighted within the NDA's strategy. Legacy ponds and silos comprise four main facilities at Sellafield which were used historically to prepare fuel for reprocessing or to store waste and are the Pile Fuel Storage Pond (PFSP), First Generation Magnox Storage Pond (FGMSP), Magnox Swarf Storage Silos (MSSS) and Pile Fuel Cladding Silo (PFCS). Radioactive materials have accumulated during operations and remain in facilities afterwards, pending the development of a retrieval capability. Over a number of decades the condition of facilities has deteriorated and there is increasing urgency to reduce the risk they pose. We recognise that to deliver the overall reduction in risk and hazard that is core to our mission we may need to accept short-term increases in risk while quiescent states are disrupted during retrieval, such as during the installation of retrieval equipment or due to changes in the partitioning of waste between the solid and liquid phased during retrieval. We will work with Sellafield Ltd and the regulators to safely manage this balance. The waste management challenges associated with the legacy ponds and silos inventory are unique due to:

- very high radioactivity inventories (alpha, beta and gamma)
- the complex nature of some poorly characterised mixed waste streams
- the asset condition of the legacy raw waste storage facilities (and the need to make near-term progress with retrieval operations)
- an evaluation of programme deliverability and prioritisation, which will include affordability considerations
- highly constraining environments, e.g. significant hydrogen generation, facilities not designed for retrievals, available space

Therefore this strategy needs to consider the Sellafield legacy ponds and silos programme separately from the rest of the estate due to the urgent need to deliver risk reduction in order to mitigate intolerable risks and potential delays in planned treatment capability. In addition, our strategy requires safe storage solutions that do not foreclose long-term management options. For the majority of the wastes stored in these ageing facilities at Sellafield achieving a single step approach to retrievals and waste conditioning to produce disposable waste products in a timely manner is difficult. We have come to understand that a single step approach may be inappropriate and an alternative strategic solution is being pursued. Where there are initial overriding safety concerns, a progressive risk and hazard reduction strategic solution of waste retrievals and raw waste containerisation can be employed, with final conditioning and packaging for disposal being deferred until a later date (see Figure A2.1).

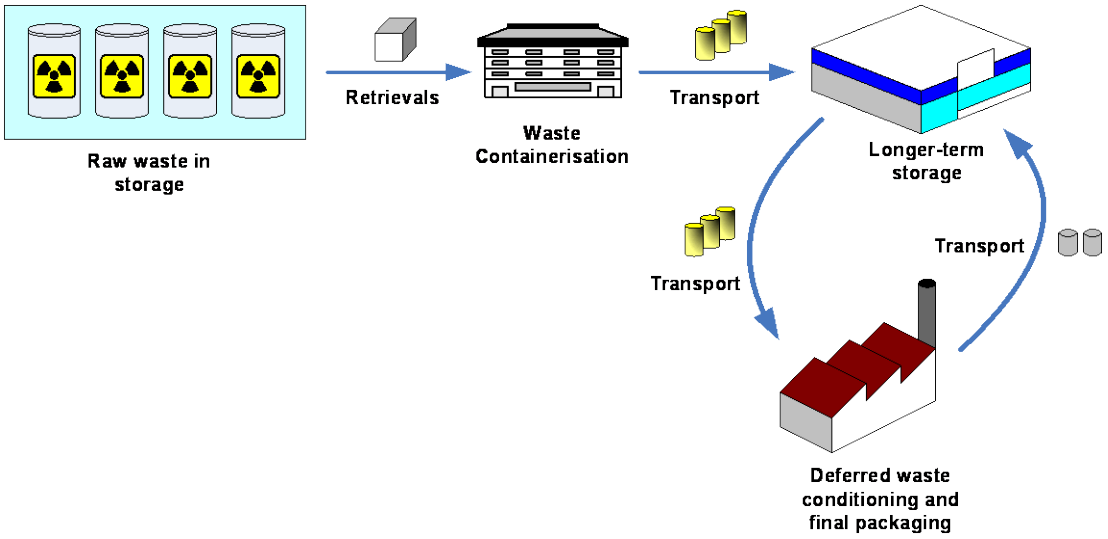

Figure A2.1 - Example of a containerisation strategy with deferred final waste conditioning

Adopting a staged process avoids commitment to a complete solution where we have an incomplete picture of the wastes. Importantly, each stage brings an opportunity to reduce uncertainty and learn more about the waste, enabling more effective development of options to prepare the waste in a form suitable for disposal. During this period where final conditioning for disposal is deferred, continued engagement between the regulators, SLC and RWM is required along with an agreed forward programme to underpin the journey from an interim or raw waste form to the final product.

For the PFCS, MSSS, FGMSP wastes and some legacy fuels this initial containerisation strategy is now the baseline position due to the need to balance timely risk reduction activities against a desire to produce disposable products. The initial step addresses the immediate risk by timely waste retrievals and emplacing raw material within specifically designed robust containers or tanks in a modern storage facility. Such an approach allows time for development of an effective treatment step (or steps) to ensure the wastes are suitable for disposal in a GDF. The NDA and the regulators expect the highest safety and security standards within these modern storage facilities that will allow for the import and export of waste containers and development of effective monitoring and inspection regimes. The NDA, with support from Sellafield Limited, will continue to develop a robust long-term HAW treatment strategy that closely considers the development of innovative solutions and a programme approach to waste treatment on the Sellafield site.

The near-term focus for legacy ponds and silos programmes is bulk retrievals of the waste. In some circumstances it may be acceptable to leave behind small volumes of difficult to retrieve wastes in the legacy facility for an agreed period of time where there is a clear benefit in support of site decommissioning and remediation imperatives. These residual wastes may be subject to *in situ* management practices that are necessary to aid longer-term asset management requirements prior to facility reactor dismantling. For example, the use of waste 'fixatives' to fix contaminants and prevent further contamination or even *in situ* local treatment technologies could be deployed. The management of any legacy ponds and silos residual waste techniques would be a Sellafield Ltd responsibility and subject to normal regulatory approvals.

The progressive risk and hazard reduction strategy for legacy ponds and silos HAW is consistent with the following NDA waste management principles:

- Supporting key risk and hazard reduction initiatives by enabling a flexible approach to long-term waste management. For some wastes it may be necessary to adopt a multi-stage process to achieve a final disposable product; this could include the separate management of

bulk retrievals and residual material to support hazard reduction programmes
- Take into consideration the entire waste management lifecycle, including how waste management supports other NDA strategic or wider UK initiatives such as large-scale decommissioning programmes.

To support developing solutions for legacy ponds and silos HAW, the aims of the programme include:

- future waste treatment options are not foreclosed
- maximise the opportunities to characterise the waste to facilitate future treatment, transport and disposal
- residual wastes retained in legacy facilities to be minimised and techniques to be deployed on an exceptional case-by-case basis
- likely disposal requirements are established early with RWM and, where possible, interim storage enacted in such a way as to minimise the steps to achieving this (*e.g.* avoiding double handling etc.)
- deliver the next generation of treatment plants that are effective in terms of producing disposable products, volume management and financial affordability

The progressive risk and hazard reduction strategy applied to legacy ponds and silos wastes is not without risk and has consequences that must be considered. For example, with interim storage of raw waste, consideration of factors such as waste evolution and corrosion, along with subsequent final treatment has to be addressed. A multi-step process to achieve a final disposable waste form must not compromise the necessary safety, security and environmental standards. It is, rather, a practical interpretation of the wider radioactive waste strategy to allow risk and hazard reduction to be addressed as a priority. It remains a strategic requirement that waste is retrieved in a timely manner, safely stored and ultimately disposed of to the appropriate disposal facility in compliance with the NDA strategy and government policy.

Appendix 3 – Waste Management Services & Frameworks

A3.1 LLW Management Services

The UK Strategy for the Management of Solid Low Level Radioactive waste requires the availability and use of fit for purpose waste routes. LLWR Ltd implemented this requirement through the development and provision of a range of waste routes and supporting services to enable the diversion of wastes from the repository. The implementation of the LLW strategy is undertaken by the National Waste Programme which facilitates and promotes the use of alternative routes. The waste services are summarised below:

Service	Summary
Waste Characterisation	Consultancy, sampling analysis, interpretation, routing and measurement services to support characterisation and segregation activities
Packaging	Container and drum supply services from a fleet of approved industrial package (IP) type 2 rated designs to support efficient waste packaging
Transport	Rail and road logistics services to optimise waste transport across the UK and reduce carbon impact
Metallic Waste	Segregation, size reduction, shot-blasting and melting services to treat and recycle metals
Combustible Waste	Thermal treatment services to incinerate wastes and reduce waste disposal volume
Supercompactable waste	High-force compaction services to improve the packaging efficiency of waste in disposal containers

Service	Summary
Very Low Level Waste	Disposal services to manage the diversion and transfer of very low level wastes to appropriately licensed commercial and hazardous waste landfill sites
Low Level Waste	Disposal services to provide long term management of LLW at the national LLW repository
Expert Services	Provision of professional services and project management support for all waste management activities
Alternative Services	Access to a range of treatment solutions for more challenging and problematic wastes

The development of a range of services and a robust programme approach to the implementation of the LLW strategy has resulted in significant cost benefits and improvements in waste management culture and behaviour. The diversion of waste from disposal to the LLW repository has resulted in significant life extension and avoided the need to develop a replacement LLW repository. This strategy will apply a similar approach to the management of all radioactive wastes where there are opportunities for optimisation.

A3.2 Waste Treatment Framework

The baseline treatment option for radioactive wastes is often cement encapsulation. It is unlikely that this is the optimal solution for all future waste streams and we will continue to support the development of a range of waste treatment technologies with the strategic aim of reducing overall waste volumes and making best use of current and future assets. To enable this we have developed the HAW Treatment Framework which details our ongoing programme of work aimed at development of alternative treatment options. This will comprise an estate-wide programme approach to waste treatment to support SLCs and RWM by undertaking specific activities to progress the development of treatment technologies considering the following:

- SLC programme approach to waste treatment where any opportunities should be highlighted within the SLC IWS
- directly sponsor R&D initiatives that help to underpin novel waste treatment and conditioning technologies
- the creation of NDA Integrated Project Teams (IPT) that support technology development and/or estate-wide solutions
- evaluation of the role of the Sellafield Site in the medium to long-term including the possibility of establishing a treatment and conditioning service where a case can been made

The main focus of the framework are waste treatment requirements between 2025 and 2060, where it is assumed it could take at least 10 years to develop an appropriate level of underpinning to be in a position to implement novel waste treatment routes. The key areas for investigation are:

Scenario	NDA Aims	Intended Outcomes
Waste Encapsulation, *e.g.* cement encapsulation	Ensure a coordinated approach to encapsulation capability across the estate.	A reduced number of encapsulation facilities compared to baseline, a selection of suitable cement formulations, established encapsulation service and a range of alternative encapsulants.
Thermal Treatment Technologies	Provide leadership to enable coordinated development of thermal treatment capability (through an IPT).	Appropriately underpinned technology being used across the estate. Some streams treated in the near-term.
Physical (Non-Intrusive): Non-Encapsulation	Provide leadership as appropriate *e.g.* through the development of industry guidance on container selection	Support effective application of containerisation across the estate. Making best use of currently available and approved containers.

Scenario	NDA Aims	Intended Outcomes
Physical and Chemical (Intrusive): Decontamination	Provide leadership as appropriate *e.g.* through the development of decontamination industry guidance.	SLCs decontaminating where there is clear benefit, using techniques known to be effective and that deliver appropriately disposable products.
Problematic Waste Management	Leadership to enable development of coordinated approach (through an IPT).	Build our understanding of the inventory across the estate and a programme of work to manage it. Some streams treated in the near-term.
Decay Storage	Provide leadership through additional guidance.	SLCs identifying and implementing opportunities where the case can be made. Clear position established with respect to the use of risk-based approach and disposal by safety case argument.