Integrated Waste Management

Radioactive Waste Strategy

September 2019

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Executive Summary

In the 2016 Nuclear Decommissioning Authority (NDA) Strategy, we made a commitment to develop this document, a single radioactive waste strategy for the NDA group. The NDA's Integrated Waste Management Strategic Objective is: "to ensure that wastes are managed in a manner that protects people and the environment, now and in the future, and in ways that comply with government policies and provide value for money."

This strategy applies to all radioactive waste generated within the NDA estate (including materials that may become waste at some point in the future).

It provides a high-level framework for flexible decision-making, to ensure safe, environmentally acceptable and cost-effective solutions that reflect the nature of the radioactive waste concerned.

A single radioactive waste strategy replaces the previous NDA strategy for Higher Activity Waste (HAW) and is consistent with the UK strategy for solid Low Level Waste (LLW), providing a consolidated position and greater clarity about our overall approach.

A single strategy also enables us to promote opportunities for managing waste across the standard waste categories; supports an approach where radioactive wastes are managed according to the nature of waste (radiological, physical and chemical properties) rather than simply the radioactive waste category they fall into; and embeds the integrated waste management principles, such as the application of the waste hierarchy and sharing treatment and storage assets.

The strategy identifies a number of areas of focus where we feel that optimisation of waste management will offer benefits to the estate. Our strategy articulates our strategic positions and preferences, focusing on the following stages:

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

We will create an integrated programme to build on the success of the existing LLW programme, which has significantly increased levels of re use and recycling, while extending the life of the LLW Repository (LLWR) by reducing volumes of waste automatically assigned for disposal in the vaults.

The integrated programme will seek to drive changes in behaviour and culture to allow waste producers greater flexibility in managing their radioactive waste effectively, as well as developing proportionate solutions.

The programme will be implemented in prioritised phases, focusing initially on areas such as wastes at the classification boundaries, waste management culture and packaging.

This strategy will deliver the benefits of greater integration, more proportionate risk-informed approaches; better coordination across the industry and reduced costs over the full lifecycle.

Waste retrieval at Sellafield

Effective, optimised waste management is essential for the delivery of our mission and forms a significant part of our 120-year programme

1. Introduction

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

The NDA's Strategic Objective for radioactive waste is: "to manage radioactive waste and dispose of it where possible, or place it in safe, secure and suitable storage, ensuring the delivery of the UK and devolved administrations policies" [1].

Effective, optimised waste management is essential for the delivery of our mission and forms a significant part of our 120-year programme. Radioactive waste must be appropriately managed until the point of disposal.

Successful site decommissioning and remediation depend on a waste management infrastructure that is robust and sustainable. Implementation of this strategy will improve how we manage waste and decommission our sites by ensuring that sustainable, effective and efficient solutions are available at the right time.

The strategy promotes the best use of our existing infrastructure and the development of new solutions when required.

Whilst primarily an NDA strategy, this document will also be of interest to other organisations involved in radioactive waste, including waste producers, facility operators, suppliers of services, regulators, local planning authorities and communities where radioactive wastes are generated and/or managed.

2. Background

Over 90% of the UK radioactive waste predicted volumes are generated by the NDA estate, covering the full spectrum of wastes contaminated or activated by radioactivity.

In the UK, radioactive wastes are classified according to the nature and quantity of radioactivity and the heat produced. The following categories are used:

High Level Waste (HLW):
waste in which the temperature may rise significantly as a result of its radioactivity and has to be taken into account in the design of storage or disposal facilities. HLW only exists at the Sellafield site. It is important to differentiate HLW from spent fuels and nuclear materials which are not currently classed as wastes.

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

Low Level Waste (LLW):
waste with 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 alongside municipal, commercial or industrial waste, or can be disposed of to specified landfill sites, subject to limits on radioactivity content.

The following broader designations are also used:

Higher Activity Waste (HAW):
comprises HLW, ILW and a small fraction of LLW.

Lower Activity Waste (LAW):
comprises both LLW and VLLW.

Radioactive wastes are produced by a number of organisations including nuclear site operators (both within and external to the NDA estate), Ministry of Defence, industry, hospitals, educational and research establishments, although the latter tend to produce only small volumes. Under their permits, waste producers are responsible for managing all the waste at their site(s).

Another potential component of the inventory for disposal is nuclear material that is not currently classified as waste but could be at some point in the future, if it is deemed to have no further use.

These materials include:

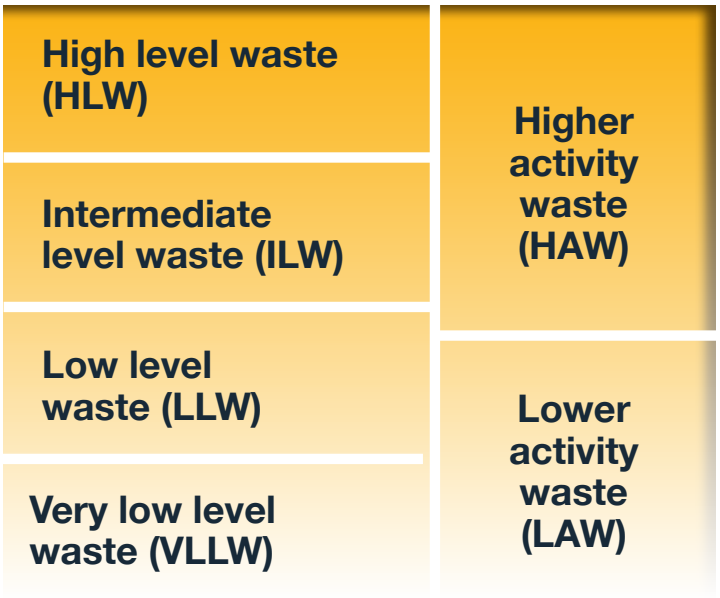
- spent fuel
- plutonium
- uranium

The UK government will decide, in conjunction with material owners, whether these should be declared as wastes in the future.

Further supporting information on the waste management policy framework and the role of NDA is provided in Appendix 1.

Other forms of waste, such as Naturally Occurring Radioactive Material (NORM), are specifically excluded from this strategy as it is addressed by a separate UK NORM Waste Management Strategy [2]. Figure 1 illustrates how HAW/LAW designations compare qualitatively against the radioactive waste categories.

FIGURE 1 – UK WASTE DESIGNATIONS




Sellafield Ltd

3. Radioactive Waste Strategy

The 2016 NDA Strategy identified that an integrated approach to radioactive waste management would provide greater opportunities for optimisation, especially for wastes at the classification boundaries of ILW/LLW and LLW/VLLW.

3.1 Scope of the strategy
The NDA strategy highlights a waste management lifecycle approach 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 this 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, which are covered by the UK Discharges Strategy [3], or non-radioactive wastes.

Effective management of 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, Nuclear Materials and Integrated Waste Management.

Looking forward, our waste management programme is changing, as bulk retrievals from legacy facilities commence, vitrification of HLW starts to draw to a close and we need to deal with large volumes of decommissioning waste, where effective boundary waste management will be essential.

This 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.

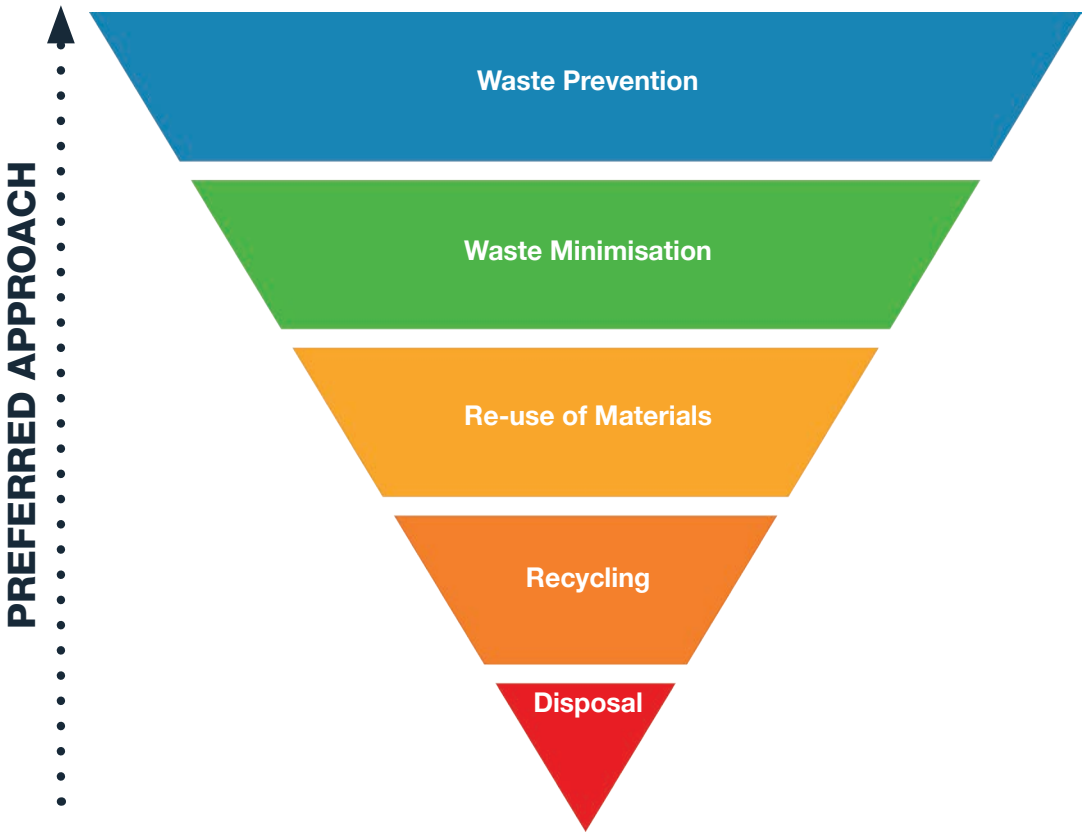
This strategy embraces our overarching Integrated Waste Management principles and informs the development and implementation of all topic strategies within the NDA Integrated Waste Management Theme:

- 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 (Figure 2) 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.

The use of the waste hierarchy (Figure 2) will help to drive waste prevention and minimise overall volumes where possible.

Waste producers should also consider the principles of radioactive waste management set out in the Office for Nuclear Regulation Safety Assessment Principles [4] and relevant guidance from the ONR and environment agencies [5].

FIGURE 2 - WASTE HIERARCHY



Whilst this document is primarily an NDA strategy, we do have obligations to make our waste management infrastructure available to the wider nuclear industry where appropriate, such as access to LLW management services, 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.

3.2 Objectives

The key objectives of this strategy are to:

- drive 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 its application in certain circumstances
- provide a robust and sustainable infrastructure, essential to the safe and effective delivery of the NDA mission by making best use of existing waste management assets and developing new fit-for-purpose waste management routes as required
- drive/facilitate changes in waste management behaviours and culture to ensure waste producers consider all stages in the waste hierarchy
- ensure waste management infrastructure is flexible to facilitate prompt decommissioning and remediation of facilities and sites where appropriate
- enable risk-informed waste management with greater emphasis placed on the nature of the waste rather than classification, to aid in identifying the most appropriate 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 infrastructure

3.3 Benefits

The single strategy promotes cross-category waste management optimisation, supports a risk-informed approach while protecting people and the environment and supports the development of an integrated programme that will enable suitable and timely waste management infrastructure to support the NDA mission.

Disposal vaults at the Low level Waste Repository

3. Radioactive Waste Strategy (continued)

Key benefits are:

- optimisation: a single strategy will provide greater opportunities to optimise the management of wastes according to the risk posed by those wastes, resulting in reduced costs and schedules
- clarity: clear articulation, in a single document, of our strategic requirements for radioactive wastes
- 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

Overall, the strategy is seeking to assist waste producers overcome a range of possible challenges, examples include:

- providing support to the site operators' key challenges of risk and hazard reduction initiatives, by enabling a flexible approach to long-term waste management.
- optimising waste management routes across the NDA estate, increasing efficiency in the treatment, storage, transport and disposal of wastes
- promoting and supporting robust decision-making processes to identify the most advantageous options for waste management

Examples of integrated waste management are shown in Appendix 2.

3.4 Interfaces with current strategies

This strategy is developed from the UK Strategy for the Management of Solid Low Level Waste from the Nuclear Industry (UK LLW strategy) [6] and the NDA Higher Activity Waste Strategy [7]. 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 is 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 (see Appendix 2.). This strategy replaces the HAW strategy.

The single strategy promotes cross-category waste management optimisation, supports a risk-informed approach to waste management while protecting people and the environment

4. 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.

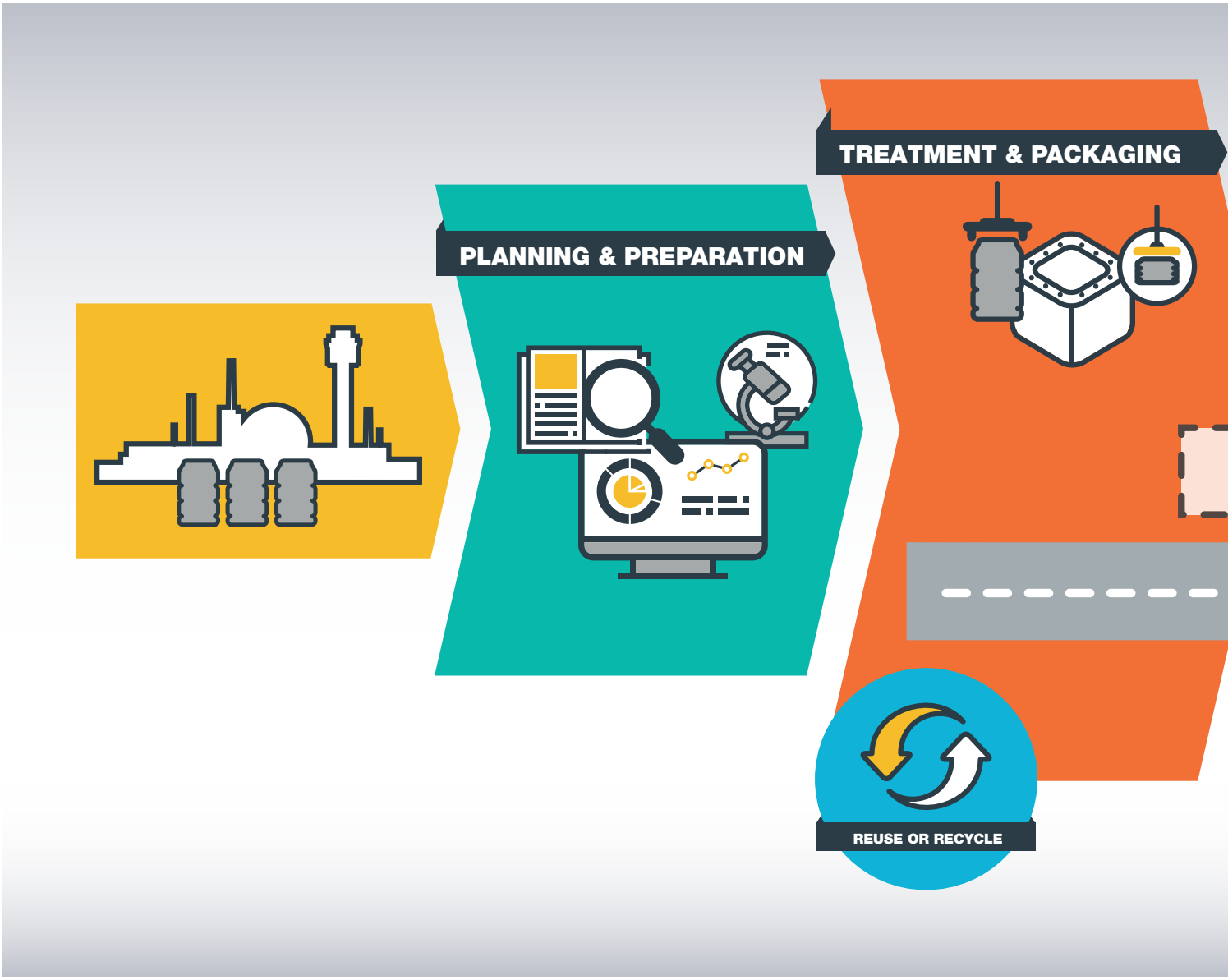
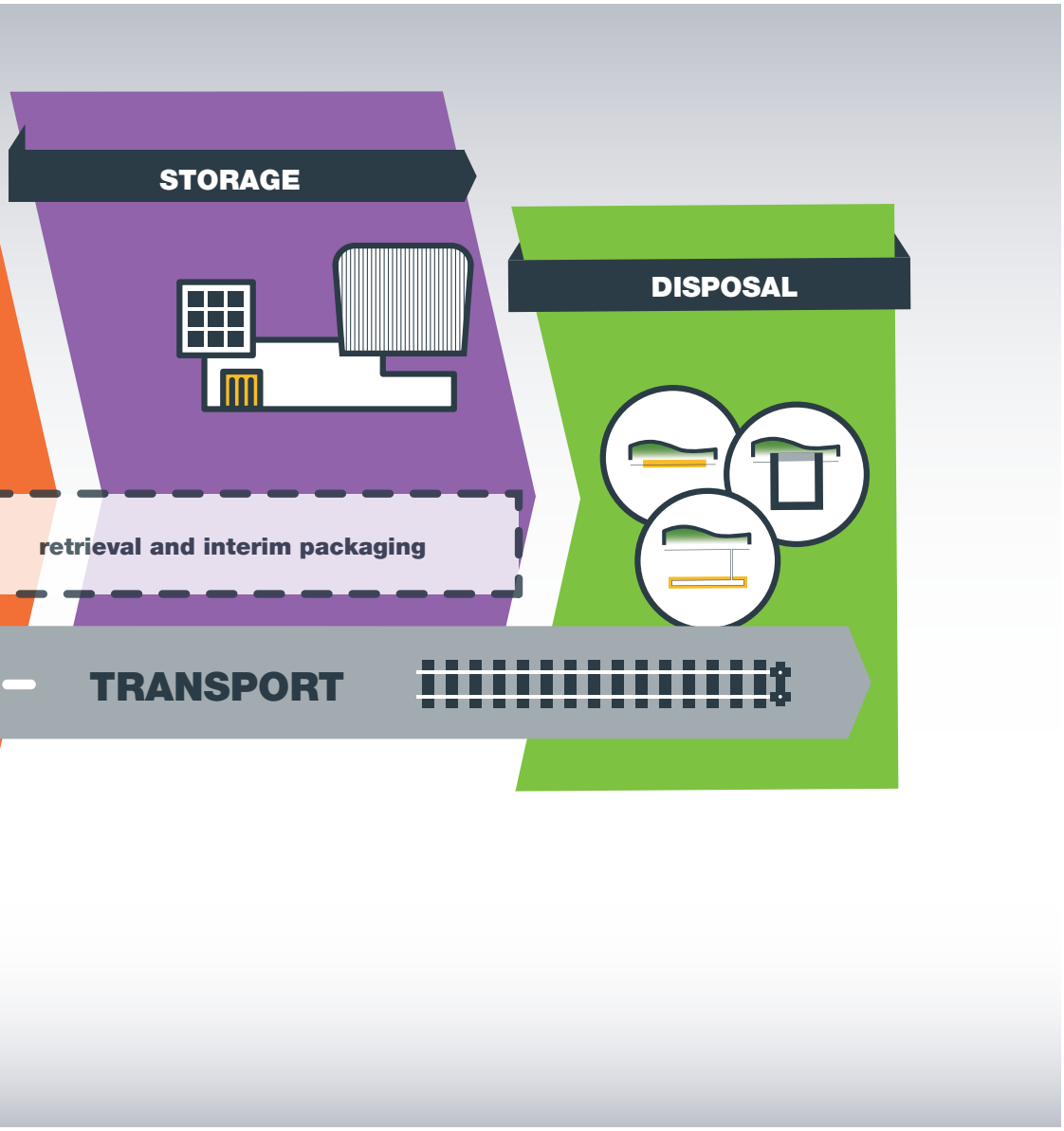


FIGURE 3- RADIOACTIVE WASTE MANAGEMENT LIFECYCLE


STORAGE
DISPOSAL
retrieval and interim packaging
TRANSPORT

4. The Radioactive Waste Management Lifecycle (continued)

4.1 Planning & Preparation

- **Integrated waste management strategies**
- **Waste management plans**
- **Waste characterisation**
- **Waste Inventories**

Planning and preparation is essential 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 integrated waste management principles.

Opportunities identified early may continue to accrue benefits throughout the lifecycle. Also, identifying opportunities to develop new management techniques on a given site may allow major efficiencies to be realised as similar issues are encountered elsewhere in the wider NDA estate and there is the potential to share infrastructure.

When making waste management decisions, we expect our SLCs to use the NDA Value Framework [8] to support the selection of a preferred option.

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) [9] on behalf of government[1]. This inventory provides the best available information on all categories of radioactive wastes and materials in the UK and is 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 via 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 and understanding the inventory play an important role in the decommissioning of nuclear facilities and for site restoration by forming the basis for:

- planning
- identification of the extent and nature of significant radioactive and non-radioactive species
- assessment of potential risk impacts
- cost estimation
- implementation of decommissioning and waste management
- safety, radiological protection and protection of the environment
- supporting decisions to release buildings and sites

In recognition of the importance of characterisation, and based on feedback from our SLCs and regulators, we are leading the production of a guidance document to detail the principles, processes and practices that should be followed 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 also essential to support waste treatment and disposal decision-making.

We 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[2]. They demonstrate that the capability and capacity exist 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 are fit for purpose via regular reviews and revisions.

1 The 'Radioactive Waste Inventory' provides an up to date record of the latest national information on radioactive wastes and materials in the UK- and provides detailed information about each waste stream

2 A radioactive waste management case (RWMC) may underpin part of the IWS. A RWMC summarises how the waste will be managed from production through to disposal. The RWMC allow transparency for waste streams that include wastes from multiple sources and demonstrates that radioactive waste is managed in a way that protects the health and interests of people and the integrity of the environment, both now and in the future, inspires public confidence and takes account of costs.

As part of the Guidance on Requirements for Release of Nuclear Sites from Radioactive Substances Regulation (GRR) [10] produced by the environmental agencies, sites are also required to produce a site-wide environmental safety case which is supported by a comprehensive waste management plan. The development of the safety case and the waste management plans will support both Site Decommissioning and Remediation and Integrated Waste Management strategic themes. 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.

To help take the radioactive waste strategy forward, the NDA will continue to lead or sponsor activities that involve:

- supporting current and future radioactive waste policy implementation
- leading and delivering strategy development tasks
- sponsoring industry integrated project teams
- creating strategic guidance
- promoting and monitoring relevant SLC practices

NDA use an Integrated Project Team (IPT) approach for the delivery of significant projects.

This approach involves the formation of multi-disciplinary teams that can span a range of organisations, to solve industry or estate-wide challenges. This approach allows us to provide leadership while leveraging skills, capability and resource from our subsidiaries, SLCs and the supply chain. IPTs are currently addressing issues with Problematic Wastes and are developing Thermal Treatment capabilities. More information is provided in Appendix 3, A3.3.

4.2 Treatment and Packaging

- **Retrievals**
- **Sorting & Segregation**
- **Size reduction**
- **Decontamination**
- **Treatment – Thermal/ Chemical/Physical**
- **Conditioning/Immobilisation**
- **Packaging**

The aim of waste treatment and packaging is to process raw waste into a form suitable for disposal, where routes are readily available, or for long-term storage pending the development of suitable disposal routes.

Waste producers must take into account the waste hierarchy to manage waste effectively and help preserve disposal capacity.

Generally, the NDA has a strategic preference towards processing waste as early as practicable, into a form that is suitable for long-term storage and/ or disposal. However, this still allows the option for pursuing alternative approaches (such as deferring treatment of wastes) where there are strong drivers to do so (such as safety). For instance:

- for some legacy high hazard facilities, waste may be removed before treatment facilities are constructed in a multi-phase waste management approach
- additionally, for certain waste arisings, it will be appropriate to defer final treatment or packaging to facilitate alternative management options and to support management of waste at the classification boundary

Please refer to Appendix 2 for examples of such decision-making.

Typically, treatment and packaging will involve a number of steps and 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
- sorting and segregation: 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 physical or chemical process to achieve either reclassification[3] 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 waste characteristics to facilitate subsequent management steps, such as recycling or disposal. 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 so the resulting product can be safely handled, transported, stored and disposed
- packaging: the process of loading waste into a container suitable for handling, storage (potentially long-term), transport and disposal

The range and types of packaging vary with the type of waste stored, the activity of the waste and whether package is intended to provide radiation shielding.

3 Reclassification of radioactive waste is the change to either a higher or lower waste category as direct result of accurate characterisation or through some form of treatment, e.g. decontamination, or segregation

Packaging also includes containerisation, which is the process of initially packaging HAW following retrieval, for storage pending pre-treatment or pending transfer for treatment and/or disposal. This is an important enabling step as careful thought is needed on the type of container used for final storage. Containerisation can offer benefits in terms of acceleration of decommissioning programmes and the removal of the requirement for encapsulation facilities and shielded stores.

4.3 Storage

- **Raw Waste Storage**
- **Conditioned Waste Storage**
- **Buffer Storage**
- **Decay 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.

LLW in the UK is generally not stored, since treatment and disposal routes are available. However, at times it may be necessary to buffer store some volumes of LLW to support treatment and/or disposal.

Where waste cannot be disposed of immediately, storage facilities are required across the estate until a treatment and/or disposal route becomes available.

Radioactive waste is stored for a number of reasons, and the high-level function for each storage type is highlighted (Table 1). In particular for HAW, storage is required until an appropriate treatment or disposal route becomes available, which could include allowance for decay to enable reclassification.

Storage 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. Interim storage which allows decay of short-lived radionuclides may achieve earlier disposal of some radioactive waste.

As well as the long-term storage of wastes on the site of origin, consolidation of wastes from several sites to a single location may also achieve wider strategic 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. Where wastes may be consolidated between sites, appropriate stakeholder engagement will be required.

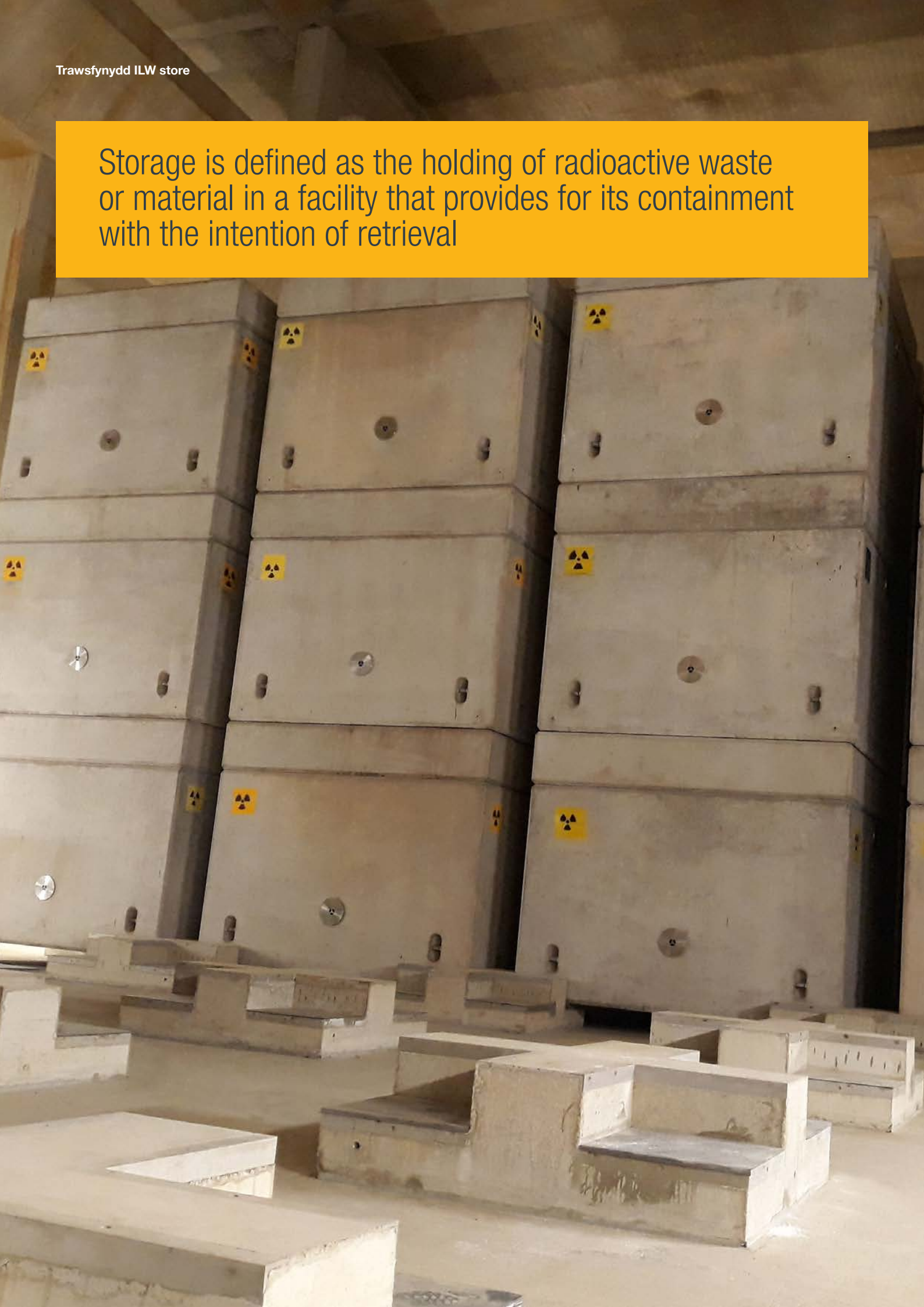
At times, it may be necessary or desirable not to foreclose options and to store containerised raw waste in modern interim storage facilities to enable decommissioning or to progress hazard reduction. Such facilities will need to comply with applicable regulatory requirements and could require an additional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

We have published storage guidance [11] 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 future construction of stores. Making the best use of existing assets and investigating store consolidation opportunities, where available, have the potential to provide cost and/or schedule benefits.

In line with UK and devolved administration policies and Committee on Radioactive Waste Management (CoRWM) recommendations, we will ensure that our strategy allows for safe and secure storage for a period of at least 100 years.

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.

ILW store at Sellafield



Trawsfynydd ILW store

Storage is defined as the holding of radioactive waste or material in a facility that provides for its containment with the intention of retrieval

TABLE 1 - RADIOACTIVE WASTE STORAGE

<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 any radioactive 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>Treated/ conditioned waste</td><td colspan="3">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>

4.4 Disposal

- **Landfill**
- ***In situ***
- **On-site**
- **Surface**
- **Near-surface**
- **Geological**

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

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 approach to developing disposal 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 produced by the environmental agencies:

- Guidance on Requirements for Authorisation of Near-surface Disposal Facilities on Land for Solid Radioactive Wastes [12]
- Geological Disposal Facilities (GDF) on Land for Solid Radioactive Waste [13]

Disposal follows a risk-informed approach and developers and operators of disposal facilities for solid radioactive waste have to demonstrate that their facilities will protect people and the environment.

In the UK, we need a range of disposal facilities to manage the variety of radioactive wastes, from *in situ* management, to licensed landfills, to a geological disposal facility for materials requiring geological isolation.

The system of waste categorisation does not readily support decision-making based on the risk posed by the waste. A risk-informed 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.

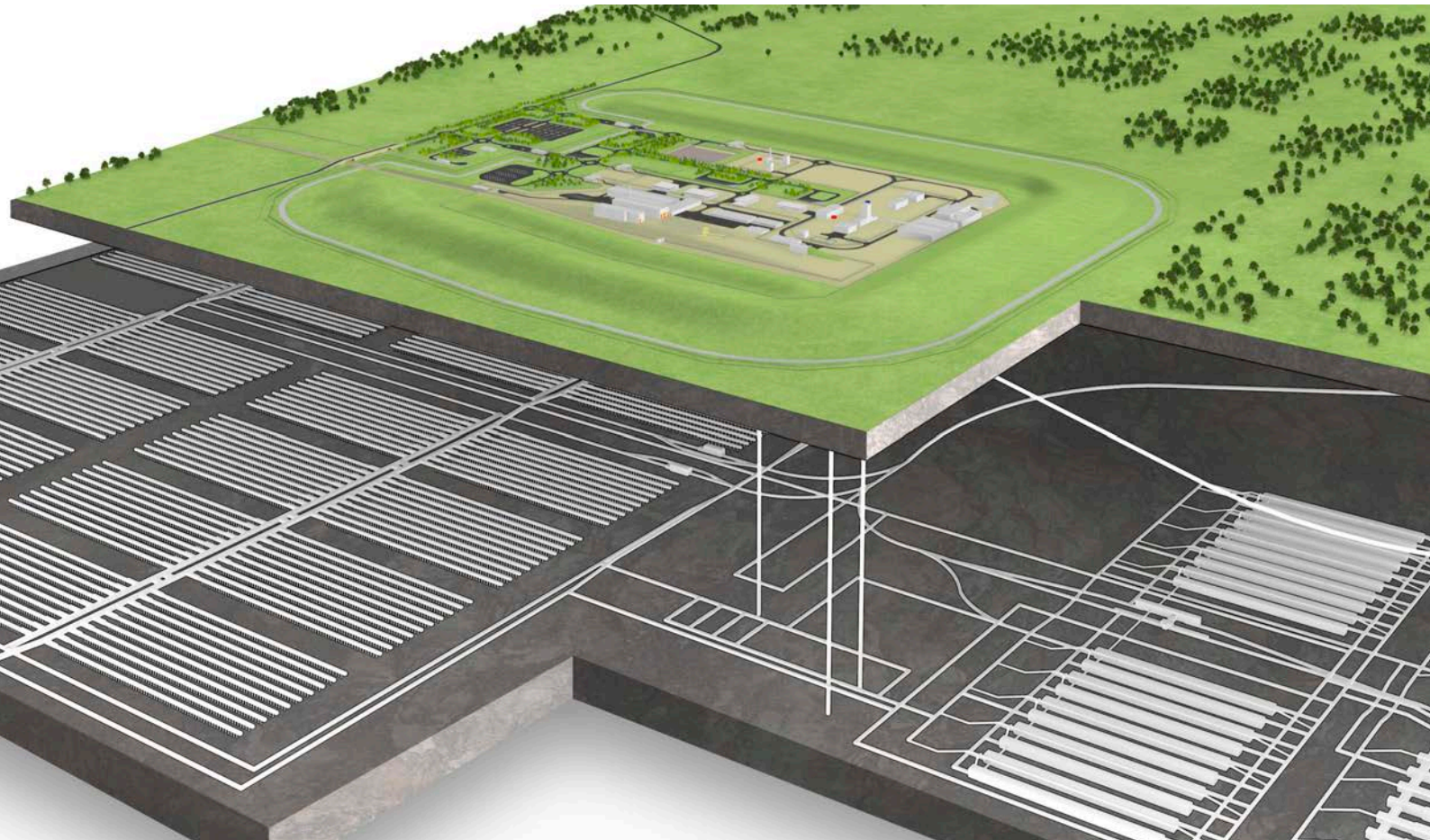
We will continue to work with government, regulators and the nuclear industry to determine how this could be optimised.

We have specific obligations to UK government and devolved administrations with respect to disposal. We own the LLWR which is managed by LLWR Limited on our behalf and provides a disposal service to both our estate and the wider UK nuclear industry.

The LLWR site is the UK's national LLW disposal facility. Its role is to ensure that the LLW generated in the UK is disposed of in a way that protects people and the environment. LLW Repository Ltd is also responsible for leading the implementation of the UK LLW strategy on behalf of the NDA, which it does through the National LLW Programme.

A key part of the UK LLW Strategy is the development of alternative waste management routes. For example, the National LLW Programme has been successful in diverting significant volumes of LLW from disposal at the LLWR site. The supply chain has developed landfill capability for the disposal of VLLW and lower-activity LLW wastes, and has a critical role in providing a safe disposal route for wastes in support of the LLW National

FIGURE 4 - UK GDF CONCEPT



Dounreay low level waste facility

Programme. We have an obligation under the UK LLW strategy to make our LLW management facilities available to other nuclear and non-nuclear managers of radioactive waste, where it is practicable to do so.

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

We, along with our subsidiary RWM, are responsible for the implementation of UK and Welsh government policies on managing HAW through geological disposal [14]. A 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 (Figure 4).

The UK government policy for implementing a GDF is based on working in partnership with local communities. A suitable site will only be taken forward if the local community supports it. This allows for communities to play an active role in determining their own long-term socio-economic development and prosperity.
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 [15]. The Welsh government policy is that a GDF can only be built in Wales if a community is willing to host it.

In Scotland, the policy is for long-term management of all waste (LLW and ILW)[4] in near-surface facilities. Scottish government's HAW policy [16] states that: "facilities should be located as near to the site where the waste is produced as possible." The Scottish government does not support deep geological disposal[5]. The NDA will continue to work with the Scottish government to implement the Scottish HAW policy.

The environment agencies have produced guidance for releasing nuclear licensed sites from the requirements of radioactive substances regulation when all activities involving the generation and disposal of radioactive wastes have ceased. This guidance provides a means whereby some radioactive waste may be managed on site either as *in situ* contamination or as a permitted 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.

In support of both UK government's HAW 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 carried out an initial technical study 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, for example, some types of ILW.

This could provide an opportunity for an earlier disposal solution, to enable site decommissioning and remediation and, in particular, risk and hazard reduction programmes.

A GDF will always be required for some HAW. Following completion of the study, 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.

A summary of disposal capability is shown opposite (Table 2).

4. There is no HLW in Scotland
5. There are a proportion of wastes which, under current technology and regulation, are understood to be unsuitable for near-surface disposal. A programme will be devised by the Scottish government and NDA to identify credible options for the long-term management of these wastes.

TABLE 2 - CURRENT, PLANNED AND POTENTIAL DISPOSAL CAPABILITY

Regulatory Guidance	Disposal Capability	Waste Category	Disposal Capability Owner	Examples of Wastes
Near-surface Disposal Facilities on Land for Solid Radioactive Wastes – Guidance on Requirements for Authorisation	On-site/*in situ* disposal (existing capability): • CLESA (Sellafield Ltd) • In situ disposal on a site specific basis	VLLW/LLW	NDA	Concrete, Rubble, Excavated soils, Asbestos, Secondary waste from other treatment processes (metals treatment, combustible etc.), redundant plant and equipment
	Specified Landfill Disposal (existing capability): • ENRMF (Landfill) • Clifton Marsh (Landfill) • Lillyhall (Landfill)	VLLW/LLW	Commercial Landfills	Concrete, Rubble, Excavated soils, Asbestos, Secondary waste from other treatment processes (metals treatment, combustible etc.), redundant plant and equipment
	LLW Repositories (existing capability): • LLWR site • DSRL LLW Facility	LLW	NDA	Personal protective equipment, redundant plant and equipment, spent filters (etc.)
	Scottish HAW Disposal Option (planned future capability)	ILW (noting that not all ILW will be suitable for disposal by this option)	To be determined	Activated steel and concrete from dismantling, graphite
	Near-Surface Disposal (England/Wales (potential future capability)	LLW/ILW	To be determined	Activated steel and concrete from dismantling, graphite
Geological Disposal Facilities on Land for Solid Radioactive Wastes – Guidance on Requirements for Authorisation	Geological Disposal Facility (planned future capability)	ILW/HLW & LLW not suitable for disposal by other routes	NDA	Fuel cladding, spent fuel, some contaminated equipment, some filters / ion exchange materials[6]

6. Another potential aspect of the inventory for disposal is nuclear material that is not currently classified as waste but could be at some point in the future, if it is deemed to have no further use. These materials include: spent fuel, plutonium and uranium. The UK government will decide in conjunction with waste owners whether or not these should be declared as wastes in the future. Additional wastes for GDF disposal from new nuclear power stations may also be produced in the future.

5. 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 Table 3 below:

TABLE 3 - STRATEGIC POSITIONS/PREFERENCES

Lifecycle stage	Waste type	Areas of strategic focus	How is this enacted
Planning and Preparation	All waste types	**Integrated Waste Strategies** - All Sites already produce an IWS 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	NDA will work with our SLCs and Regulators to ensure that our guidance and specification for IWS continues to be fit for purpose. We will regularly review and revise our guidance as appropriate
	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 requirements	The waste inventory is a requirement of the Radioactive Substances Regulation (RSR) permits and the UKRWI is an international reporting requirement. NDA will continue to work with government, The regulators and the industry to identify and implement areas for improvement
	VLLW, LLW & ILW	**Boundary Waste** - The use of a risk-informed 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 risk-informed management of wastes at the boundary between waste categories could be optimised. NDA recognise that this type of risk-informed waste approach may not be able to be implemented at all locations
	VLLW, LLW & ILW	**Waste Characterisation** – Characterisation forms the basis of robust waste management plans and allows waste producers to effectively implement the waste management hierarchy	NDA continues to work with regulators and the industry to develop a Waste Characterisation Good Practice Guide to detail the principles, processes and practices that should be followed when characterising solid radioactive wastes across all SLC's. We will review and update this guidance as necessary
Treatment and Packaging	HLW	**Vitrification** – Highly active liquor from the reprocessing of spent fuel is vitrified to produce HLW which is stored pending disposal to the GDF. HLW is only produced and managed at the Sellafield site	Our strategy is mature in this area and we are expecting to complete the programme. No alternative options for the treatment of such wastes are required

Lifecycle stage	Waste type	Areas of strategic focus	How is this enacted
Treatment and Packaging	ILW	**Treatment** - The baseline treatment option for radioactive wastes is often cement encapsulation, which is unlikely to be the optimal solution for all future waste streams. NDA is exploring the strategic opportunities where alternative treatment technologies could offer advantages in terms of cost savings, risk reduction, waste product quality, and volume reduction. NDA strategy drives greater integration by sharing existing and future assets and capability where it is appropriate to do so	**Treatment Framework** –NDA continues to invest in our portfolio of research and development in this area through the Direct Research Portfolio. Broadening the available technology options also provides a level of contingency to the baseline treatment position
		Retrieval – At some facilities where our immediate priority is near-term risk reduction wastes are being retrieved and packaged for interim storage in modern facilities knowing that further waste treatment steps may be necessary prior to disposal	NDA will continue to provide strategic direction in this area to help our SLCs with planning and preparation. To achieve this aim, NDA is reviewing the current approach to the development and use of waste packages and will report its findings in due course. RWM will ensure appropriate guidance on the selection and use of container types is available to waste producers
		Problematic Wastes – These are wastes that have no defined waste treatment and/or disposal route available, or for which existing routes are significantly suboptimal. These wastes are considered problematic by virtue of their physical, chemical and / or radiological properties	NDA has formed an Integrated Project Team, led by RWM and LLW Repository Ltd, to evaluate the inventory of problematic wastes, sharing information and identifying solutions to develop a coordinated approach to their management. This work delivers benefits across the NDA estate, and the wider industry
	LLW & ILW	**Boundary Waste** – Many opportunities to optimise the waste lifecycle and apply the waste hierarchy occur where wastes are close to the boundary between categories. This is anticipated to be an increasing proportion of the inventory of waste arisings as we move in to decommissioning and final site clearance. Through effective characterisation and targeted treatment, it is possible to take a risk-informed approach, minimising the volumes of waste destined for geological disposal and reducing the number of ISO containers disposed of at the LLWR	NDA will continue to work with SLCs and regulators to help determine and progress the main opportunities for alternative management of wastes at the ILW and LLW boundaries
	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	LLW Repository Ltd. facilitates a range of waste treatment services to maximise diversion from disposal at the LLWR, in order to reduce LLW volumes and preserve disposal capacity
Storage	HAW	**Waste Storage** – The current strategy is to safely and securely store waste until disposal routes become available. To implement this strategy all new interim stores will have a design life of 100 years or more with appropriate care & maintenance programmes in place	NDA have established the Store Operators Forum and developed industry guidance to promote good practice for HAW storage

Lifecycle stage	Waste type	Areas of strategic focus	How is this enacted
Disposal	VLLW & LLW	**Existing Disposal Capability** – Some of our SLCs also carry out on or near-surface disposal of LLW and/or VLLW. DSRL operates a VLLW and LLW disposal facility adjacent to their site and Sellafield Ltd. operate an on-site disposal facility for VLLW. A number of commercially available landfill sites capable of accepting low activity LLW are also available through the LLW Repository Ltd. waste services framework	Delivery of the NDA mission requires the continued capability and capacity for the safe, secure and environmentally responsible management and disposal of VLLW and LLW in the UK 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 GRR
	LLW & ILW	**Near-Surface Disposal** – The UK policy on the long-term management of HAW (graphite falls into this category) recognises that it is appropriate to investigate alternative options to a GDF for some of the inventory where there could be the potential to improve the overall management of HAW. The NDA has carried out an initial technical study to investigate the feasibility of near-surface facilities for the disposal of some ILW in England and Wales, e.g. certain decommissioning wastes	NDA's strategic preference is to develop NSD and we will support government policy development in this area
	HAW	**GDF Implementation** – NDA will continue to implement government policy for the management of HAW through geological disposal. We are working with our delivery body RWM, to develop a geological disposal facility for England and Wales **Overseas Owned HLW** – Sellafield Ltd. 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 **HAW arising in Scotland** – Scottish government's long-term HAW is near-surface near-site management of HAW arising in Scotland	NDA and RWM are working to optimise the approach to implementing geological disposal, including our process for disposability assessment and testing the current assumptions regarding disposal of HLW We continue to support Scottish government in the implementation of its HAW policy RWM continue to monitor international developments and seek improvements as necessary

6. Radioactive Waste Strategy Implementation

The historical position of separate LLW and HAW strategies is no longer fit for purpose as the programme moves towards supporting large-scale decommissioning and site remediation.

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.

6.1. Programme Approach to Delivery

The UK LLW Policy [17] 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 was tasked with implementing it on our behalf. To support the implementation, a National LLW Programme was formed, overseen by a programme board comprising senior representatives from LLW Repository Ltd, 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 among 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,
- 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. This outcome 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.

We will create an integrated programme that will evolve over time to drive changes in waste management behaviour and culture, to allow waste producers to flexibly and effectively manage their radioactive waste as well as to develop proportionate waste management solutions.

The programme will be implemented in phases with the initial focus on identifying opportunities to deliver significant benefits in the areas of 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-informed 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 progress with programme implementation and successes.

The NDA has published its Mission Progress Report [18] to describe progress against the mission. Against the strategic themes of Decommissioning and Site Remediation, Integrated Waste Management, Spent Fuel and Nuclear Materials, we have collated data from across the NDA estate to present our progress since 2005 and show the key interfaces between these themes. In addition, we are developing site-level progress reporting to show NDA sites' progress with decommissioning and waste management.

6.2 Waste Management Infrastructure

The implementation of our strategy depends on robust, sustainable waste management infrastructure. The existing infrastructure comprises a combination of SLC and supply chain capability that meets the current needs of the waste producers.

The NDA's supply chain strategy is to help maintain and, where necessary, create and develop a healthy, vibrant, effective and competitive supply chain. The LLW National Programme has been particularly successful in introducing new supply chain routes to support delivery of the UK LLW Strategy and in facilitating changes in waste management behaviour.

The existing LLW management capabilities and the planned GDF are, and will be available for all radioactive waste producers. For HAW, much of the infrastructure will be delivered within the NDA estate and the challenge of implementing the radioactive waste strategy will focus on making best use of existing and future planned assets and the timely delivery of effective and innovative waste management solutions. In the near-term there are limited opportunities to further optimise the management of some of the radioactive waste inventory, particularly HLW and high-end ILW. For these waste streams, the focus is on implementing current plans and developing infrastructure necessary for future lifecycle stages through to disposal.

We see significant potential for infrastructure development particularly around the boundary between LLW and ILW where application of clear guidance and flexible approaches allow us to develop the right infrastructure to deliver effective and timely waste management capability to support decommissioning. We will continue to pursue these opportunities through our IPTs and the integrated programme.

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

6.3 Critical Enablers

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

6.3.1 People

Implementation 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.

6.3.2 Information Governance

Effective and robust information and knowledge management systems are necessary for the development of baseline plans and the identification of strategic opportunities. 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 applied and we will work with our SLCs, subsidiaries and regulators to ensure that effective

Transport 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

LLWR operations

knowledge management systems are maintained.

6.3.3 Transport and Logistics
Transport 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.

The NDA recognises the need to address safety aspects in developing plans for transportation of wastes. Radiological safety of waste transport is addressed by comprehensive transport safety cases.

The NDA also recognises that transportation of waste is an issue of great importance to communities, and that effective stakeholder engagement is required relating to major waste transport decisions.

An example of such stakeholder engagement is the Site Stakeholder Groups (SSGs) who act as the interface between the NDA, the local communities near NDA sites, and the site operator.

6.3.4 Research and Development (R&D)
The NDA's radioactive waste management programme needs to be technically underpinned to ensure effective delivery. NDA will continually push for better solutions and to have programmes of R&D to allow NDA to do this. 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.

6.3.5 Stakeholder and Public Engagement
Public and stakeholder engagement is key to building the support, confidence and trust necessary for us to deliver the radioactive waste management programme. It is important that our decision-making is informed by a diverse range of views and that there is a clear rationale for major decisions and the processes by which they are reached.

We pursue the goal of open and transparent engagement, tailored and proportionate to the topic or issue, and we will work with stakeholders to ensure that our stakeholder engagement meets their needs.

6.3.6 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 International Atomic Energy Agency (IAEA) and the Organisation for Economic Cooperation and Development (OECD) Nuclear Energy Agency (NEA) and also other decommissioning and waste management companies in France, the US and Japan, among 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 engage 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.

7. References

1. Nuclear Decommissioning Authority Strategy, April 2016
2. Strategy for the Management of Naturally Occurring Radioactive Material Waste in the United Kingdom, July 2014
3. UK Strategy for Radioactive Discharges, July 2009
4. Office for Nuclear Regulation, Safety Assessment Principles for Nuclear Facilities, 2014
5. The Management of Higher Activity Radioactive Waste on Nuclear Licensed Sites, February 2015
6. UK Strategy for the Management of Solid Low Level Waste from the Nuclear Industry, February 2016
7. Nuclear Decommissioning Authority Higher Activity Waste Strategy, May 2016
8. Nuclear Decommissioning Authority Value Framework, January 2016
9. UK Radioactive Waste Inventory Report, April 2016
10. Management of radioactive waste from decommissioning of nuclear sites: Guidance on Requirements for Release from Radioactive Substances Regulation, July 2018
11. Nuclear Decommissioning Authority Industry Guidance, Interim Storage of Higher Activity Waste Packages – Integrated Approach
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13. Geological Disposal Facilities on Land for Solid Radioactive Wastes: Guidance on Requirements for Authorisation, February 2009
14. Implementing Geological Disposal – Working with Communities: An updated framework for the long-term management of higher activity radioactive waste, December 2018
15. Welsh government Policy on the Management and Disposal of Higher Activity Radioactive Waste, 2015
16. Scotland's Higher Activity Radioactive Waste Policy, January 2011
17. Policy for the Long Term Management of Solid Low Level Radioactive Waste in the United Kingdom, March 2007
18. Nuclear Decommissioning Authority Mission Progress Reporting, July 2019

Appendix 1 – Supporting Information

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

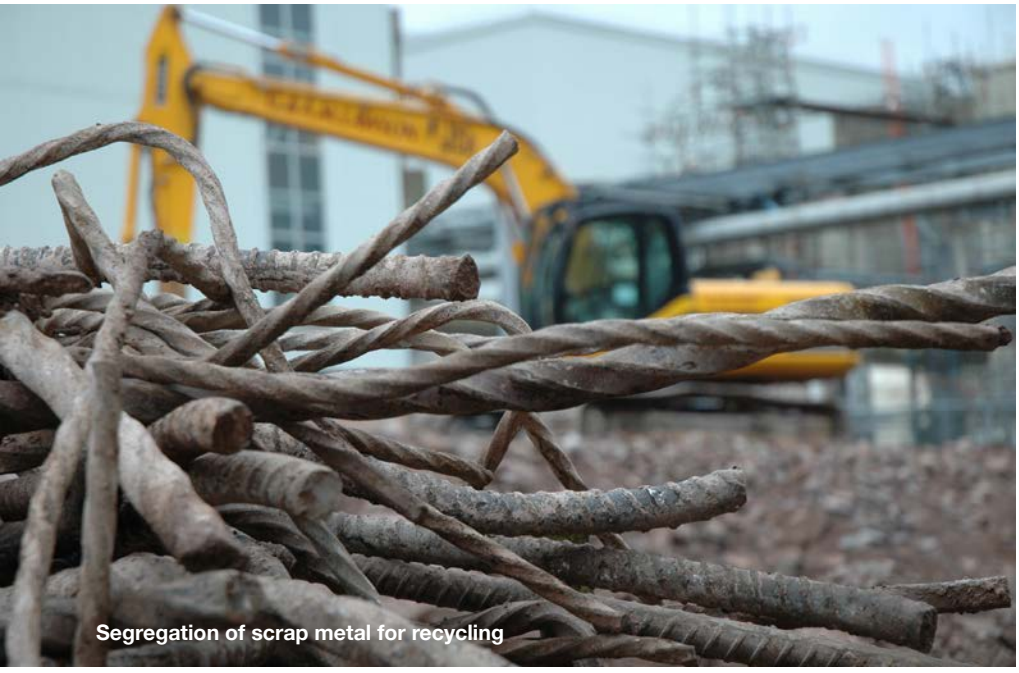
A1.1 - Radioactive Waste Policies and Strategies

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 set out 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. The current policy [14], published by the UK government, reiterates the need for the geological disposal of HAW and sets out a framework for working with communities in order to find a suitable site.

The working with communities policy also notes 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 4.4)

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 and would therefore be routed to a GDF in England/Wales.



Segregation of scrap metal for recycling

The Welsh government has participated in the MRWS programme since its inception in 2001 and consulted on its 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 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 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 Welsh government has recently published its policy for engaging with

communities and the support available for communities which may wish to enter discussions, without prior commitment, about potentially hosting a GDF.

The Scottish government is not a sponsor of the programme for implementing geological disposal and published its policy on HAW in January 2011 [16]. 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-based 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

> 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

- in the case of long-term storage or disposal facilities, consideration of the potential effects of future climate change

Using the waste hierarchy as presented in the policy, sites are working to prevent/mitigate radioactive waste arisings in the first place by, for example:

- minimising the exposure of equipment and packaging to radiation to reduce the quantity of radioactive waste produced
- sorting wastes on site to identify items or parts of items contaminated by higher levels of radioactivity. These 'hotspots' can then be separated out and sent for disposal, whilst the remaining material may be suitable for reuse or recycling
- reducing the volume of the waste to ensure best use of the limited space in our disposal facilities. Techniques include compaction and incineration

These activities help waste producers to manage their materials more effectively, reduce costs and save valuable space at disposal facilities.

The LLW policy also set out a number of requirements for the NDA, including the development and implementation of a UK 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.

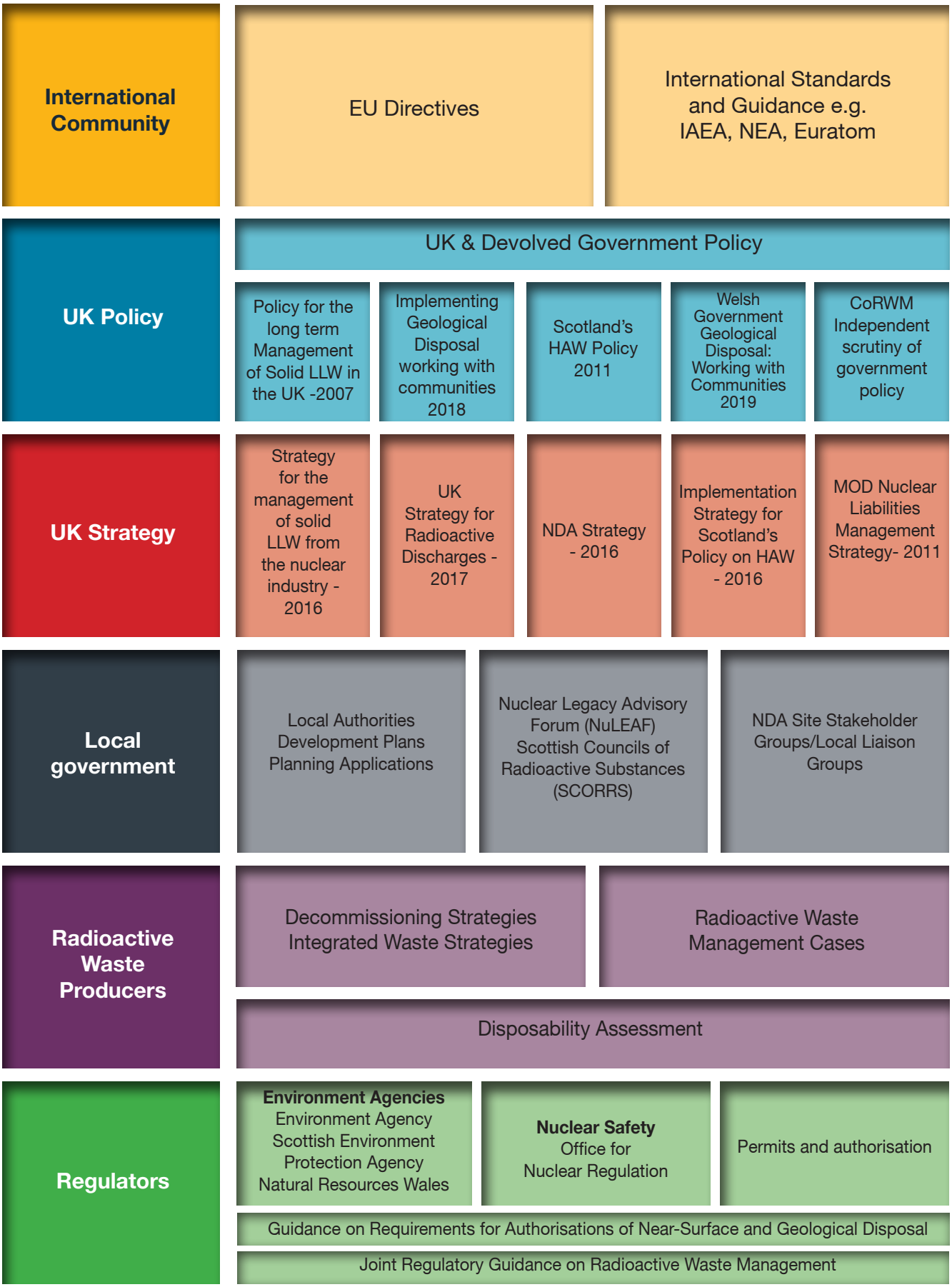
Following the introduction of the LLW policy, the UK LLW Strategy was published in August 2010 [6].

This strategy dramatically changed the LLW management environment and has resulted in a significant diversion of LLW from disposal at 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 LLW Strategy.

The 2010 UK LLW Strategy was reviewed, updated and reissued in February 2016 to reflect the changes and maturity of the LLW strategy. However, the key themes remain unchanged: application of the waste hierarchy, making best use of existing assets and development of alternative waste management routes.
The Council Directive 2011/70/ EURATOM requires European Union

FIGURE 5 - THE WASTE MANAGEMENT POLICY FRAMEWORK



Appendix 1 – Supporting Information (continued)

member states to have national programmes that ensure the safe management of spent nuclear fuel 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.

A1.2 Role of the NDA
The NDA implements policies set by government. We work with the UK government and devolved administrations to ensure their policies are reflected in our strategy and implemented at our sites.

The UK government is responsible for reserved matters including nuclear energy, security and safety. The devolved administrations are able to exercise powers in relation to certain areas, including environmental protection and radioactive waste management.

How we implement these policies is set out in the NDA Strategy, which develops over time to reflect any policy changes introduced by government. UK government and the Scottish ministers approve our strategy and business plans.

We deliver our role through 5 overarching core processes:

Strategy
Our strategy is reviewed every 5 years and provides the framework for delivering our mission on behalf of government. It sets out our strategic direction and long-term objectives and determines how the NDA is going to deliver its policy obligations. We have developed a Strategy Management System to support the development of strategic options and make decisions on a series of distinct issues.

Planning
Our plans set out how we will deliver the key outcomes required to achieve our mission in the right time frame and within the funding agreed with government.

The planning process helps us to make estate-wide decisions over the short and long term and ensures we are prepared for government spending reviews.

Our Business Plan provides:

- a 20-year overview of estate activities
- planned activities across the estate within the next 3 years

Specification
The development of specifications enables us to put in place arrangements for the management and operation of our sites through SLCs and in some cases their Parent Body Organisations (PBOs).

Our specifications provide a framework for setting out our requirements and expectations. They are designed to:

- deliver our desired outcomes
- enable effective performance management
- provide appropriate reward

Managing performance
We manage the performance of SLCs through analysis of:

- performance and programme/ project plans
- proposals for managing deviations from plans

We ensure that the SLCs comply with their specifications and deliver the required outcomes.

Using appropriate mechanisms, incentives and governance frameworks, we rigorously verify claims ensuring that there is robust professional challenge and dialogue as appropriate.

We report performance of the SLCs to the NDA board, government and stakeholders.

Assurance
We ensure the SLCs, the NDA and our subsidiaries achieve the outcomes our mission requires by:

- using risk-informed planning
- conducting assurance
- providing specialist support

This process ensures that we have the right people, processes and plans in place to ensure that hazards are reducing as planned.

A1.3 - Radioactive Waste Inventory
The UK Radioactive Waste & Materials Inventory provides the latest record of information on radioactive wastes in the UK. It has been compiled by the Department for Business, Energy and Industrial Strategy (BEIS) and the NDA.

The UK Radioactive Waste & Materials Inventory is updated every three years. It is a snapshot of radioactive wastes and materials at a specific point in time, called the 'stock date'. The 2016 Inventory has a stock date of 1 April 2016 [9].

The Inventory contains information about:

- radioactive wastes that exist now
- radioactive wastes that will arise in the future
- radioactive materials – these are substances not designated as waste now, but which might be in the future if no further use can be found for them

The Inventory includes HLW, ILW and LLW, and some High-Volume VLLW where there is reasonable certainty of the total waste arisings.

The Inventory does not include:

- liquid and gaseous wastes containing very low concentrations of radioactivity that are routinely discharged to the environment in accordance with statutory regulations. Discharges are made within authorised limits, usually after some form of abatement
- small quantities of solid wastes with very low concentrations of radioactivity typically from hospitals, universities and the non-nuclear industry (so-called 'small users') that can be disposed of with domestic refuse to landfill, either directly or after incineration
- Naturally Occurring Radioactive Materials (NORM), which accumulate as scale on pipework during the extraction of oil and gas. This scale can contain raised levels of radioactivity and is treated as radioactive waste
- estimates of waste and spent fuel from the future development of new nuclear power stations in the UK

The Inventory helps the UK to plan safe and efficient radioactive waste and materials management routes, with high standards of protection for people and the environment.

The Inventory:

- enables the UK to meet international reporting obligations
- informs policy and strategy development
- aids radioactive waste and material management planning
- supports stakeholder engagement

Updating The Inventory is a major task which happens every three years. It involves engaging with waste producers and collecting information for over 1,300 radioactive wastes and more than 70 radioactive materials. The NDA is currently compiling the 2019 updated inventory.

The Inventory has an important role in supporting waste management planning, strategy development and stakeholder engagement.

It is therefore important that information contained within the Inventory is based on the best available data and that data providers are able to maintain a programme of continual inventory improvement.

The NDA maintains an Inventory Data Improvement Plan for each data provider to help achieve this. These plans raise awareness of key areas for improvement and opportunities for eliminating data gaps, and for NDA SLCs feeds into existing improvement plans.

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

Appendix 2 – Examples of integrated waste management

The general policies discussed in this document may be implemented differently depending on the specific circumstances existing on a given site. Two examples are given below to show the efficient management of wastes for differing situations:

A 2.1 Consolidated Waste Management – Magnox Sites
In 2014, a review of radioactive waste management strategies was carried out in a number of key areas, across the Magnox estate, such as:

- LW packaging
- ILW interim storage
- Fuel Element Debris (FED) management

This review looked again at all credible options and included the approach to ILW packaging, and the technical approach to management of FED (not just the location of facilities, as was the case with the previous studies).

The assessment was also informed by the development of new waste treatment routes and a better understanding of waste arisings. On this basis, and following refinement over subsequent years, the strategies for each site were optimised.

ILW Packaging
Revised to identify the best packaging strategy for a given site or waste, within wider initiatives such as consolidated ILW Interim Storage. This review was based on identifying that 'unshielded encapsulation' was best deployed where the volume of waste to package is large and the infrastructure requirements can be offset by the low container costs. Alternatively, whether self-shielded containers are appropriate because waste volumes

FED retrievals at Bradwell


Legacy storage pond at Sellafield

are low and the increased container costs can be offset by the reduced infrastructure requirements.

Interim Storage
Use of alternative waste management routes and consolidation where appropriate has avoided building ILW stores at Dungeness A, Sizewell A, Oldbury and Wylfa. To enable this, ILW packages are transported to existing ILW stores: in the South East to Bradwell; and in the South West to Berkeley.

FED management
Revised to adopt segregation and prompt disposal of LLW FED from Sizewell A and Oldbury to LLWR, with packaging of Hinkley Point A FED for ILW disposal. A combination of these approaches was applied at Bradwell along with FED dissolution. Some of the key benefits of this include:

- significant reduction in cost, offering better value to the taxpayer
- low technical complexity, with good safety performance, minimising risk to workers
- provides opportunities to remove or stabilise hazards earlier
- aligns with government policy and NDA Strategy on prompt liability management where possible

In summary, taking a holistic view of waste arisings and requirements across all the Magnox sites has allowed existing infrastructure to be used to the greatest effect. The revised strategies have avoided building additional storage facilities, reducing cost to the taxpayer, and have also improved safety and allowed on-site risks to be managed earlier.
These strategies are now being implemented. All of the required ILW Interim Storage facilities have been constructed. Transfers of LLW FED to LLWR commenced in 2017 and ILW package transfers commenced in 2018.

A 2.2 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.

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

Appendix 2 – Examples of integrated waste management (continued)

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 protection, key stakeholder management 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 [1]. Legacy ponds and silos comprise four main facilities at Sellafield used historically to prepare fuel for reprocessing or to store waste: 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, such as 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 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 6).

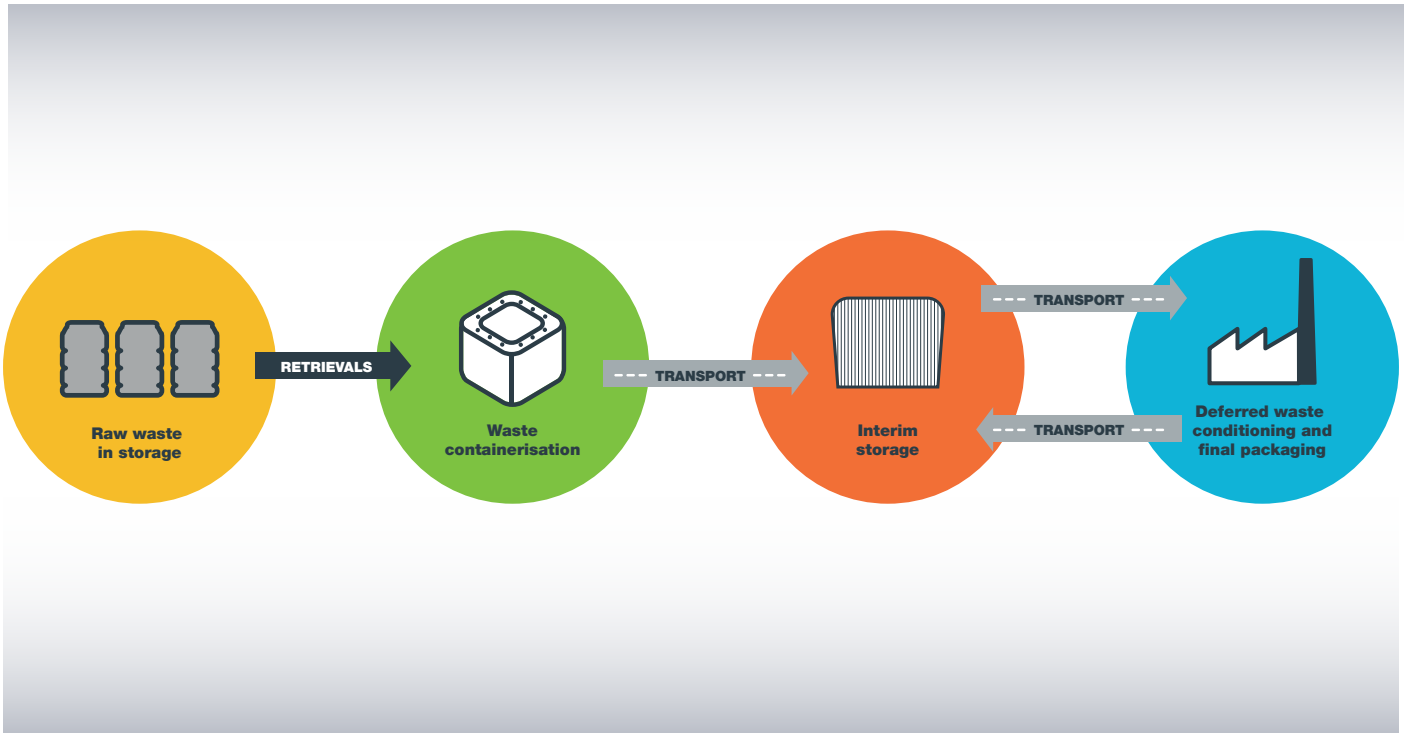


FIGURE 6 - EXAMPLE OF A CONTAINERISATION WITH DEFERRED FINAL WASTE CONDITIONING

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 Ltd, will continue to develop a robust long-term 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 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 pond and silo wastes is consistent with the following NDA waste management principles:

- supporting key risk and hazard reduction initiatives by enabling a flexible approach to long-term

Appendix 2 – Examples of integrated waste management (continued)

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
- 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

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 (such as 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 LLW Strategy requires the availability and use of fit-for-purpose waste routes.

LLW Repository 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 UK LLW strategy is undertaken by the National Waste Programme which facilitates and promotes the use of alternative routes. The National Waste Programme is an industry-wide collaboration led by LLW Repository Ltd on behalf of the NDA.

The intended benefits of this programme were as follows:

- the life of the LLWR is increased to 2130
- overall waste management costs are reduced
- optimised LLW management supports and enables effective hazard reduction and decommissioning
- continued application of the waste hierarchy
- stakeholders are increasingly engaged with its delivery

The waste services are summarised in Table 4:

TABLE 4 - SUMMARY OF WASTE SERVICES

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
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 at the LLWR has resulted in significant life extension and avoided the need to develop a replacement LLWR.

A3.2 HAW Waste Treatment Framework

The baseline option for HAW 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 be 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 summarised in Table 5:

TABLE 5 - KEY AREAS OF INVESTIGATION FOR WASTE TREATMENT REQUIREMENTS

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)	Demonstrations used to underpin appropriate thermal treatment technologies for potential use across the estate. Some waste streams thermally 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
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	Improved approach to Problematic Waste Management	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-informed approach and disposal by safety case argument

A3.3 Integrated Project Teams
We use IPTs to develop our approach to cross industry issues. Under the Integrated Waste Management Theme, we currently have IPTs to develop thermal treatment technologies and to improve the management of problematic wastes:

Thermal Treatment-IPT

Thermal treatment technologies (such as vitrification) can reduce waste volumes and produce passive waste products. Thermal treatment technologies can be designed with wide acceptance criteria, making them flexible to accommodate the variety of current and anticipated waste arisings on the NDA estate.

The Thermal Treatment IPT (TT-IPT), led by Sellafield Ltd, aims to take an estate-wide approach to the development of thermal treatment technologies for HAW. The IPT brings together the range of skills required to progress the project aims, drawing on resource from a number of organisations (primarily NDA, SL and National Nuclear Laboratory (NNL).

The TT-IPT is developing and demonstrating the technical capabilities by proving the viability of thermal treatment processes on radioactive waste, at pilot scale, under UK nuclear site license conditions.

Problematic Waste-IPT

Many sites have small volumes of radioactive wastes where management is problematic owing to their age, chemical and physical properties, radioactivity and the environment in which they are stored. The management of such wastes is a cross-industry issue and a coordinated approach supports earlier and more efficient management. The Problematic Waste IPT (PW-IPT), led by LLW Repository Ltd and RWM, was established to facilitate a cultural change in the industry by driving an improved approach to problematic waste management. The IPT is delivering this by:

- collating an inventory of problematic wastes to improve understanding and identify opportunities
- delivering a programme of R&D to identify and implement waste management solutions for problematic waste
- acting as a focal point for the sharing and exchange of knowledge between waste producers, and other stakeholders, on problematic waste management issues
- developing and supporting a community of waste practitioners involved in problematic waste management to share learning and good practice
- raising the profile and visibility of problematic waste issues within the nuclear industry

Response to consultation

General
The consultation on our Radioactive Waste Strategy ran from 30 July 2018 to 31 October 2018, receiving 19 formal responses. We have considered feedback and made appropriate changes to amend the document since the draft was published.

The strategy received a positive reception with general support for the move to a single radioactive waste strategy. Most of the comments received were specific in nature and although not individually referred to in this document, have resulted in changes to the text and tables. A number of comments and suggestions came up on several occasions. These are covered below, along with the amendments made in response.

If respondents feel that their feedback has not been adequately addressed, then enquiries can be submitted to us via IWM@nda.gov.uk.

Role of NDA in Radioactive Waste Management
A number of general questions and comments related to the NDA's role in relation to radioactive waste management. These covered topics such safety, value for money and cost.

In Section 2, we have added some information about our overarching principles within the Integrated Waste Management Theme, covering, for example, health, safety and environment, affordability and value for money. This should help to explain the context of this strategy and how it applies to the wider NDA Strategy published in 2016.

Stakeholder Engagement
A number of comments related to stakeholder engagement. Some commentators stressed that local community and stakeholder support would be critical for successful development and implementation of a radioactive waste strategy. Others commented effective early engagement with key stakeholders and communities would be required on any proposed changes to how waste is dealt with.

We have added a section on Stakeholder and Public Engagement in Section 6 of the document as well as referencing the importance of effective stakeholder engagement throughout.

Decision-making and the Value Framework
A number of questions and comments focused on waste management decision-making and the NDA value framework. As an example, one respondent felt that the process for making some key decisions should be explained, such as whether early treatment and conditioning presents lower risk and greater value for money.

The NDA uses its Strategy Management System (SMS) to manage its Strategy development in distinct stages. In selecting our preferred strategy, we consider the options against a wide range of factors – our Value Framework. The Value Framework factors balance our top priority of risk and hazard reduction alongside socio-political and affordability considerations. To aid understanding, we have included some examples of decision-making in the document.

Waste Hierarchy
We received a number of comments suggesting there needed to be more emphasis on the importance of the waste hierarchy. Respondents felt only limited consideration had been given to this and that opportunities to drive its application across the waste management lifecycle had been missed.

The waste hierarchy is a key IWM principle and a very important part of the Strategy. To get this message across and address the comments received, we have added an explanation about the waste hierarchy and referred to it throughout the document. This should give greater emphasis on its importance in the management of the entire radioactive waste spectrum.

Supply Chain
A number of respondents made the point that the success of the Radioactive Waste Strategy was dependent on the supply chain, amongst others. This was particularly important in areas such as developing treatment techniques, ongoing replenishment of landfill capacity and availability of other waste routes.

We have strengthened the document with increased references to the supply chain's role in providing routes and infrastructure for waste management.

Management of nuclear materials
Some people commented that there was scope for confusion between wastes and nuclear materials especially when referring to "materials that may become waste at some point in the future".

We have therefore provided greater clarity on the management of nuclear materials and ensured that the information is consistent with the information provided in the government white paper – 'Implementing geological disposal – working with communities: long-term management of higher activity radioactive waste'