

UK Radioactive Higher Activity Waste Storage Review



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Nuclear
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Authority



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Executive Summary

Nuclear Decommissioning Authority (NDA) Strategy, published in March 2006, made a clear commitment to hazard and environmental risk reduction by ensuring that radioactive waste is managed and converted into a passively safe form as soon as reasonably practicable and placed into interim storage. Within the strategy, NDA made a commitment to review interim storage of packaged waste opportunities within the UK. The Committee on Radioactive Waste Management (CoRWM) also covered interim higher activity waste (HAW) storage within their recommendations to Government in 2006.

In response to CoRWM Recommendation 2, Government stated that *'Safe and secure storage of radioactive waste is already a responsibility of the NDA, who manage this through lifetime plans (LTPs) that are owned by NDA site licensee contractors who run the existing civil public sector nuclear sites. As detailed in its current strategy, the NDA is reviewing its interim storage needs and it will now be required to take account of this recommendation by CoRWM in conducting the review. The outcome of the NDA's interim storage review will require approval by Government and, subject to that approval will be incorporated in a future review of the NDA's Strategy.'* This position was subsequently confirmed in the Managing Radioactive Waste Safely White paper, June 2008.

This Review includes storage regimes for solid intermediate level waste (ILW) (raw and immobilised) and for high level waste (HLW) across the UK on both NDA and non-NDA sites and considered the following; waste conditioning plans, existing store information (where a waste is due to be relocated to a new store), store design lives and lifetime extension capability, store environmental controls, monitoring and inspection regimes and storage optimisation of conditioned wastes.

Spent fuels and nuclear materials are not covered because they have not been declared as waste. A separate review is proposed to address storage of these materials.

In this Review references to Government generally mean the UK, Scottish and Welsh Assembly Governments but in regard to geological disposal references only apply to UK and Welsh Assembly Governments. The Scottish Government does not support deep geological disposal and is developing a detailed statement of its policy of long term interim storage for higher activity wastes. The NDA is working with the Scottish Government in developing its detailed statement of policy and will take account of the implications of the policy on the long term storage requirements.

Key findings and main conclusions can be summarised into the following headings that takes into account Government's response to CoRWM Recommendation 2, NDA Strategy and developing Scottish Policy;

- Waste Packaging
- Interim Storage
- Security
- Storage Optimisation
- Transport

Key Findings and Main conclusions

Waste Packaging

- NDA's priority is to deal with high hazard, high environmental risk facilities (the majority of which are at Sellafield and Dounreay) ensuring that the wastes are removed from ageing facilities at the earliest safe opportunity.
- All wastes being conditioned for long-term storage and disposal should be supported by safety cases underpinned by an understanding of how the conditioned waste and waste containers will evolve over time.
- As of the 31 March 2008, approximately 22,000 m³ of ILW has been recovered, conditioned, packaged and placed into interim storage, which equates to approximately 8% of the total ILW inventory.
- New methods for waste treatment and packaging are being considered and NDA continues to support innovative approaches to waste management.

Interim Storage

- Raw wastes in historical facilities often carry the greatest level of environmental risk across the NDA estate because of the limitations in the design of the facilities and their reliance on active systems to maintain their safety and environmental protection status.
- In principle the '100 years or more' interim storage objective may be attainable.
- A new storage strategy will be implemented if the GDF is not available beyond 2100 with the exception of HAW stored in Scotland.
- There exists 19 longer-term engineered ILW stores across the UK and a single store located at Sellafield that holds the HLW vitrified product all of modern design.
- Periodic monitoring should be undertaken to provide confidence that the waste packages are evolving as predicted and within the bounds considered acceptable in the safety cases. Experience at Sellafield has shown the importance of this as some packages have not been behaving as expected. This has been detected by waste package monitoring and therefore gives Sellafield the opportunity to put in place the necessary work to improve understanding of the evolution processes and to assess whether any remedial work will be required.
- The NDA will continue to support the Scottish Government in the development of its detailed statement of policy of long term storage for higher activity wastes.
- The latest and future waste stores are designed to align with the timeline for GDF availability dates. They will all require appropriate maintenance and various levels of in-service refurbishment, meeting CoRWM's '100 years or more' objective. The stores will be subject to periodic safety case review throughout the operational life of the store ensuring any necessary and timely improvements are made.
- A number of existing packaged waste stores have shorter notional design lives and are likely to require relatively more extensive in-service refurbishment to achieve 100 years or more objective. It is possible that in some cases it would be better to transfer wastes into another more modern store. Further work is needed to assess what would need to be done to extend the lives of individual stores and investigate whether replacement stores might be needed.
- This Review has highlighted the importance of understanding when key decisions on storage operations must take place. These decision points are affected by the planned operational lifetime of the storage facility, ongoing modern storage capacity and any changes to the planned availability of the GDF. For the existing modern stores at Sellafield the earliest timeframes for major decisions is likely to begin in 2030 assuming that the stores continue to satisfy ongoing safety case requirements.

Security

- OCNS regulates the civil nuclear industry by means of the Nuclear Industries Security Regulations 2003 (NISR 03). NISR 03 requires nuclear licensed sites to have approved Site Security Plans (SSPs). SSPs are protectively marked and they detail the standards, procedures and specific arrangements that must be kept in place to ensure the security of the nuclear premises, nuclear material in whatever category, form or quantity and sensitive nuclear information against the malicious capabilities posed by the Nuclear Industries Malicious Capabilities Planning Assumptions.
- SSPs allows a judgement to be made with regard to the malicious capabilities that could be deployed against a licensed site or transporters, and against which security measures should provide protection. It draws on intelligence provided by the national intelligence agencies particularly the Joint Terrorist Analysis Centre of which OCNS is a member.
- Operators submit their SSPs to OCNS for approval before they are adopted and thereafter, they become the basis against which they are judged to be compliant with the regulations. Once approved SSPs are regarded as live documents and subject to constant review, scrutiny and amendment as necessary by the operator concerned and by OCNS through regulatory activity.
- The security of nuclear material transported outside of licensed sites is covered in a similar manner using Transport Security Plans (TSPs) and Transport Security Statements (TSSs). Nuclear material should ideally spend the least possible time in transit and be subject to the least number of inter-modal changes.
- In his last Annual Report the Director, Civil Nuclear Security, stated that security in the nuclear industry was effective.

Storage Optimisation

- The Review of Storage Optimisation concluded that the main focus of investigating storage opportunities for NDA packaged ILW should be southern Magnox and UKAEA sites.
- NDA has no intention of pursuing a radically altered waste storage regime such as a single very large low maintenance UK facility.
- NDA should continue to encourage waste treatment, packaging and decay storage opportunities available to SLCs to help reduce the overall NDA liability, *i.e.* reduce the overall volume of ILW in storage (and potentially the number of ILW interim stores), and thus increase storage flexibility.
- There may be opportunities to extend the study to include other waste owners for example, it may be sensible to consider a single ILW store for co-generation BE/NDA sites.
- Stakeholder engagement is a key consideration and should be applied to any proposal to transfer wastes including planning authorities, the Regulators and local communities.

Transport

- Compliance with transport regulations/requirements will be required to be demonstrated in addition to compliance with disposal acceptance criteria, as waste packages will be transported within the public domain.
- Public and stakeholder engagement is an essential activity and has to be an integral part of the interim storage programme.

Way forward and further work

As this Review mainly focussed on Government's response to CoRWM Recommendation 2 and the NDA strategy commitment on ILW Storage Optimisation, there are areas of further work which could focus on specific issues raised. A series of more detailed reviews should also be considered as part of a forward programme and co-ordinated *via* the NDA's HAW Strategy team. The key principles going forward are:

- An integrated lifecycle approach to HAW management that takes into consideration regulation, Government Policy and evolving techniques.

- Effective public stakeholder engagement is a key component for the success of new approaches.

NDA with input and support from its stakeholders has compiled a list of potential topics as part of the process to create its future work programme. These identified areas include:

- Transport arrangements
- Waste characterisation
- Integration and standard approaches
- Waste packaging
- Interim storage of waste
- Storage optimisation
- Common issues

As a result of the Review, there are a number of immediate next steps:

- The NDA will share ideas with relevant parties who have direct responsibility for areas of work outside of the NDA's accountability for them to progress directly.
- Where NDA does have the relevant accountability, it will consider the areas of work identified as part of the process of defining its future plans.
- NDA will ensure that its forward programme continues to support its Strategy Management System and in particular the development of the HAW Topic Strategy.

The approach to the interim storage of higher activity wastes should be reviewed on a regular basis with clear links to the development of Government policies.

Chapter 1: Background and current management arrangements for Higher Activity Wastes

1.1 NDA Strategy

Nuclear Decommissioning Authority (NDA) strategy, published in March 2006, made a clear commitment to hazard and environmental risk reduction by ensuring that radioactive waste is managed and converted into a passively safe form as soon as reasonably practicable and placed into interim storage. Within the strategy, NDA made a commitment to review interim storage opportunities within the UK.

This work scope has since evolved to align with the Managing Radioactive Waste Safely (MRWS) process and also incorporates CoRWM's recommendation to Government on interim storage, and Government's subsequent response. The Review covers all the NDA, British Energy and MoD sites that currently store or will produce higher activity (high and intermediate level) radioactive wastes in the future.

1.2 CoRWM recommendations

This report is NDA's response to a recommendation on the storage of higher activity waste (HAW) made by the Government's Committee on Radioactive Waste Management (CoRWM) in July 2006. The materials covered are Intermediate Level Waste (ILW) and High Level Waste (HLW).

The report focuses on CoRWM's recommendation 2 which stated:¹

CoRWM Recommendation 2: A robust programme of interim storage must play an integral part in the long-term management strategy. The uncertainties surrounding the implementation of geological disposal, including social and ethical concerns, lead CoRWM to recommend a continued commitment to the safe and secure management of wastes that is robust against the risk of delay or failure in the geological disposal facility programme. Due regard should be paid to:

- *reviewing and ensuring security, particularly against terrorist attacks*
- *ensuring the longevity of the stores themselves*
- *prompt immobilisation of waste leading to passively safe waste forms*
- *minimising the need for repackaging of the wastes*
- *the implications for transport of wastes.*

Government's response to this recommendation is reproduced below.²

Government accepts this recommendation. The planning and development to deliver geological disposal will take several decades. Government considers that it is essential that radioactive waste is stored safely and securely at all times until its emplacement in a facility, in a manner that protects both people and the environment.

¹ <http://www.corwm.org.uk/pdf/FullReport.pdf>

² <http://www.defra.gov.uk/environment/radioactivity/waste/pdf/corwm-govresponse.pdf>

Safe and secure storage of radioactive waste is a responsibility of the NDA. This is managed through LTPs that are owned by NDA site licensee contractors who run the existing civil public sector nuclear sites. As detailed in its current Strategy, the NDA is reviewing its interim storage needs and is required to take account of this recommendation by CoRWM in conducting the review. The outcome of the NDA's interim storage review will require approval by Government and, subject to that approval will be incorporated in a future review of the NDA's Strategy.

This review will pay due regard to the possibility of unforeseen circumstances in its planning, including possible delays in geological disposal facility development. It will ensure that a holistic view is taken through the complete waste management chain, ensuring that both long and short term issues are addressed in a fully coordinated and integrated manner.

In response to CoRWM's more specific points:

- The security of all stores is of paramount importance. The NDA's contractors are regulated and advised by the Office for Civil Nuclear Security and already take account of such matters including the design and engineering of new stores and the refurbishment of existing ones in light of the risks to the security of their contents, now and into the future. This includes, but is not limited to, the vulnerability of the waste form and the degree of protection provided against attack.*
- The design of new stores will allow for a period of interim storage of at least 100 years to cover uncertainties associated with the implementation of a geological disposal facility. The replacement of stores will be avoided wherever possible, but the NDA will ensure that its strategy allows for the safe and secure storage of the waste contained within them for a period of at least 100 years.*
- Government and regulators agree that wastes should be made passively safe as soon as practicable. This is consistent with the need to avoid any requirement for future repackaging and the attendant double handling of wastes. The NDA will consider this need in developing its strategy and plans and will report on progress in its annual reports.*
- In developing its Strategy and plans the NDA will keep under review the packaging requirements, so as to minimise the possibility that waste will have to be repackaged whilst in storage, which, as CoRWM note, is considered undesirable by the regulators. The strategy and plans will continue to be subject to independent regulatory scrutiny as at present.*
- In developing its storage and disposal strategy in the coming years, the NDA will consider the implications for waste transport, in particular, to minimise movements of unconditioned waste as far as possible. In this it will also pay due regard to the existing waste distribution, and possible future arisings, as well as the need for safe and secure stores, and the uncertainties regarding siting of future disposal facilities.*

A robust programme of interim storage must play an integral part in the long-term management strategy. Interim storage will also provide for certain categories of new wastes arisings which will require storage before disposal even after a disposal facility is operational.

This position was subsequently confirmed in the MRWS White paper, June 2008.

On 25 June 2007 the Scottish Government published³ its position on interim storage of waste withdrawing its initial support⁴ for the CoRWM recommendation of deep geological disposal of radioactive waste. This has a bearing on the interim storage of waste.

³ <http://www.scotland.gov.uk/News/Releases/2007/06/25101822>

⁴ <http://www.scotland.gov.uk/News/Releases/2006/10/25143454>

The NDA is also responsible for overseeing British Energy's (BE's) planning for and the decommissioning of its nuclear power plants. This is a supervisory function only and does not bring responsibility for the actual decommissioning work. This is because, as owner and licensee of its sites, BE is responsible for their clean-up. The restructuring of BE in 2002 provided a new and robust funding framework for discharging BE's nuclear liabilities with the taxpayer stepping in if the funding was insufficient. In order to mitigate against this possibility Her Majesty's Government (HMG) charged the NDA with oversight of BE's liabilities, notably the review and approving of BE's strategies, plans and budgets for decommissioning and discharge of uncontracted liabilities, and approval of expenditure on qualifying clean-up projects.

Interactions between the NDA and the Ministry of Defence (MoD) are governed by a Memorandum of Understanding (MoU) between the two organisations. It is necessary and desirable for the NDA and the MoD to interact primarily because several of the Site Licence Companies (SLCs) of the NDA are contracted to provide services to the MoD. These services range from storage of MoD owned materials to operational support for the MoD Submarine Enterprise.

There is a secondary but nonetheless important interaction between the two organisations, and that is to seek out value for money opportunities in the area of information and technique sharing. It has become apparent over time that some of the tools and techniques that the NDA and its SLCs have developed, using public funds, could be applicable to the MoD in pursuit of its management of its nuclear liabilities. This represents an area of potential savings to the Taxpayer. One example of value for money collaboration is that the MoD has requested the use of the NDA's 'toolkit' for the writing and management of Lifetime Plans. The NDA has made this toolkit available to the MoD.

1.3 Scope of the UK Radioactive Higher Activity Storage Review

The main purpose of this Review is to understand the robustness of longer term storage of radioactive HAW in the UK. In order to understand the robustness of storage plans a series of key parameters were examined. These include waste conditioning plans, existing store information (where a waste is due to be relocated to a new store), store design lives and lifetime extension capability, store environmental controls, monitoring and inspection regimes and storage optimisation of conditioned wastes. In addition to the parameters above, the review addresses the five points specifically raised by CoRWM regarding interim storage:

- reviewing and ensuring security, particularly against terrorist attacks;
- ensuring the longevity of the stores themselves;
- prompt immobilisation of waste leading to passively safe waste forms;
- minimising the need for repackaging of the wastes;
- the implications for transport of wastes.

This Review uses data supplied by waste producers. It considers raw or unconditioned waste stored in historical facilities, although it does not provide a detailed analysis of the current condition of these facilities. The retrieval of historical material from ageing facilities is recognised as an urgent issue and in most cases represents the highest priority for the NDA, near-term programmes, reflecting application of the NDA prioritisation process⁵ and as well as being subject to continued Regulator scrutiny.

The storage of spent fuel and nuclear materials is not included in this Review and will be reviewed separately by NDA. Furthermore, it does not consider radioactive wastes, which may arise from a 'new build' nuclear power programme.

⁵ <http://www.nda.gov.uk/documents/upload/EGPR02-NDA-Prioritisation-Procedure-Rev3.pdf>

1.4 Current management arrangements for Higher Activity Wastes

Higher Activity Wastes (HAW) refers to all radioactive material that has no further use and applies to all High Level Waste (HLW), Intermediate Level Waste (ILW) and a relatively small volume of Low Level Waste (LLW). HAW excludes spent fuel and nuclear materials. The Government's White Paper on 'A Framework for Implementing Geological Disposal' Chapter 3: section 3.3 also provides further detail on HAW.

1.4.1 High level waste (HLW)



HLW arises as a fission product bearing liquid when spent fuel is reprocessed at Sellafield. This liquid generates heat and is stored in cooled tanks before it is evaporated and vitrified in glass. It is then stored in a dedicated facility on the site for at least 50 years in line with Government policy. In the UK, HLW only exists at Sellafield.

Disposing of HLW at the same location as ILW in the GDF is being considered as part of the MRWS decision process.

The vitrified product provides a passive safe waste form for interim storage and Sellafield is now working with NDA's Radioactive Waste Management Directorate (RWMD) to improve confidence that the products will be compliant with transport and geological disposal requirements.

1.4.2 Intermediate Level Waste (ILW)

ILW is defined as material having alpha radioactivity of greater than 4 GBq per tonne or beta/gamma activity of greater than 12 GBq per tonne. It differs from HLW in that it does not require heat to be taken into account in the design of storage or disposal facilities.

Figure 1 – an example of a waste disposal container – the three cubic metre box



Currently in the UK there are five different ways of storing ILW:

- Untreated, *i.e.* raw waste, in historical storage facilities.
- Historically treated waste in storage that needs further treatment before long-term storage/disposal.
- Interim storage of waste already conditioned for disposal.
- The continued storage of wastes in modern engineered stores that will require further conditioning before disposal.
- Waste *in situ* such as in reactor cores awaiting decommissioning.

A small proportion of Low Level Waste is also included in the HAW category, as this waste is not currently suitable for disposal in the LLW Repository (LLWR) near the village of Drigg in West Cumbria. Such LLW may consist of effluent treatment sludges with high concentration of alpha activity or reactor core graphite, which contains relatively high concentrations of long-lived radioisotopes.

1.4.3 Historical ILW facilities

Prior to the investment in modern waste processing facilities, which now convert wastes to a passive safe and disposable form, a large amount of ILW was produced and consigned in raw form to a variety of vaults, tanks, ponds, silos and other storage facilities (see Figure 2). Operations at the time did not give sufficient consideration to issues such as retrieval, facility decommissioning or the long-term fate of the waste. These 'Historical Wastes' (sometimes referred to as legacy wastes) date from the 1950s onwards, when the national imperatives were very different to those today and wastes were 'dispatched' to these facilities with little regard for their future retrieval. Wastes were poorly segregated and full inventory records necessary for future waste management were not captured or retained. These facilities fall short of modern standards and are not suitable for longer-term storage of wastes.

Figure 2 – Magnox storage pond at Sellafield



The strategy now is very different and this is reflected in the priorities and funding described in the NDA Business Plan.⁶ Sellafield and other holders of historical wastes are working closely with RWMD to achieve improved passivity of these wastes by conditioning into a form suitable for interim storage and ultimate geological disposal. This shall be achieved through safe waste retrieval, waste treatment and effective conditioning, taking due regard of safety, environmental, key stakeholder and cost factors. In line with Government policy the default approach is to achieve disposable products, without the need for future re-packaging. The asset management of these historical facilities is vital in enabling the wastes to be safely retrieved and processed while ensuring protection of the environment. However, in some cases, disposable packages may only be achieved in a staged approach, where the immediate priority is near term environmental risk and hazard reduction.

Some historical wastes that have been subject to earlier processing are not suitable for long-term storage or geological disposal, e.g. sea dump drums prepared in the 1980s and storage of unconditioned waste in 200 litre drums. It is proposed that these wastes are 'repackaged' appropriately in new waste packages that are suitable for interim storage and final disposal.

Although some of this early waste was treated and immobilised, it was placed in packages which are not now suitable for long-term storage or geological disposal and would not meet today's regulatory requirements. These will be repackaged into forms suitable for interim storage and disposal.

1.5 Today

The main NDA strategic priority is to reduce hazard and environmental risk on the sites for which it is responsible by ensuring that the radioactive wastes are converted into a safe passive form as soon as reasonably practicable and disposed of once disposal facilities are available. To assist in focussing its resources, and to demonstrate progress in its mission, NDA has initiated the 'Hazard Baseline Project' and in the first place considers HLW and ILW (excluding operational wastes), as these dominate the waste hazard profile.

The Hazard Baseline Project has enabled the NDA to gain an accurate picture of the current status of ILW management in the UK from a waste inventory and waste condition perspective (see Figure 3). The NDA's draft 2009/12 Business Plan includes further detail on the Hazard Baseline Project. Appendix 1 gives an overview of waste and hazard definitions used by this project.

Radioactive waste continues to be generated across the UK from decommissioning operations and commercial operations at NDA sites. The majority of this is treated, as it arises and conditioned in line with the regulatory requirements to form passively safe and disposable waste products which meet the RWMD's LoC standard. The remaining waste is stored untreated in purpose-built facilities but the volumes will continue to increase until they are packaged prior to export to the GDF.

1.5.1 Hazard and risk

Hazard and risk are defined by the NDA as follows⁷:

- *Hazard is the potential for harm arising from an intrinsic property or disposition of something to cause detriment'.*
- *Risk is the combination of chance and consequence that someone or something that is valued is adversely affected in a stipulated way by the hazard.*

Retrieval, conditioning and storage of radioactive wastes require the continuous management of risk and hazard.

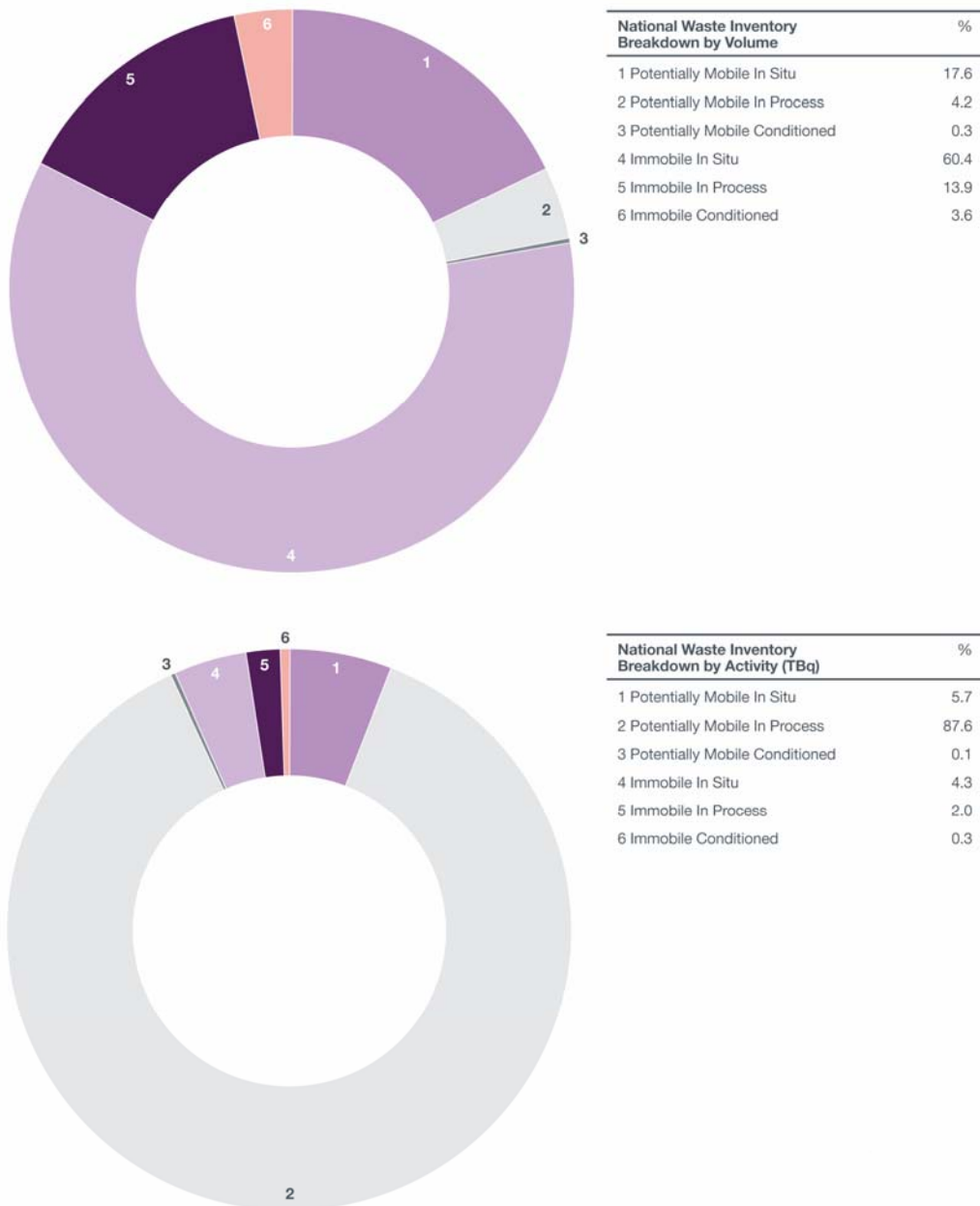
⁶ <http://www.nda.gov.uk/documents/upload/NDA-Business-Plan-2008-2011.pdf>

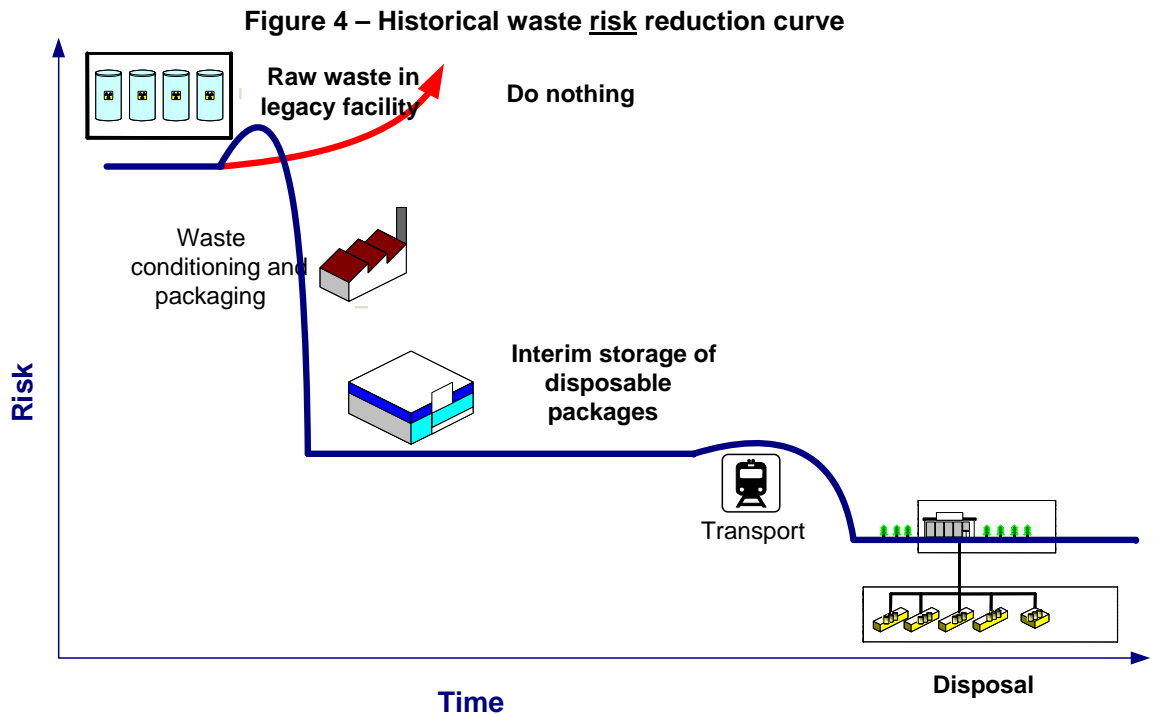
⁷ NDA Prioritisation Process, EGPR02, Rev 4, May 2008.

The most hazardous material within the NDA portfolio is liquid high level waste. However, the highest risk posed throughout the portfolio is from miscellaneous materials including reactive metals, fuel residues and corrosion product sludge within the Historical Facilities at Sellafield. Although the sludge is a relatively lower hazard than the liquid high level waste the risk is driven by the relatively poor containment of the sludge provided by its current storage in an old building structure. Retrieval of the sludge will likely to result in a short term increase in risk (as illustrated in Figure 4). However, after conditioning the risk will decrease substantially below current levels.

Once waste is conditioned, the inherent hazard posed will decrease due to the reduction in mobility of radiological and chemical species. Decommissioning of some historical facilities once the waste has been retrieved and conditioned is also a major hazard reduction activity. Contaminated facilities themselves are essentially waste in storage, and across the NDA estate there are facilities dating back to the late 1940's, which would not meet modern structural design standards.

Figure 3 – NDA's Hazard Baseline Project - the quantities of ILW and HLW present on NDA sites as at 1 April 2007, both in volume and activity





1.5.2 NDA safety and environmental detriment score (SED)

As stated previously, the NDA has developed a prioritisation process⁸. This process centres on the Safety and Environmental Detriment (SED) which is an NDA developed metric. The SED score is a numerical representation of hazard and risk of a facility and its inventory. The SED score is composed of the following components.

- Radiological Hazard Potential (RHP) – a metric for the hazard potential of a radioactive material.
- Chemical Hazard Potential (CHP) – a metric for the hazard potential of a chemical.
- Facility Descriptor (FD) – facility descriptor which reflects the current status of the facility being assessed to contain a specific waste inventory.
- Waste Uncertainty Descriptor (WUD) – waste uncertainty descriptor which most suitably reflects the nature and condition of the waste inventory.
- Ongoing Environmental Detriment (OED) – this covers the ongoing electricity usage throughout care and maintenance in order to maintain a facility in a safe and legal state.

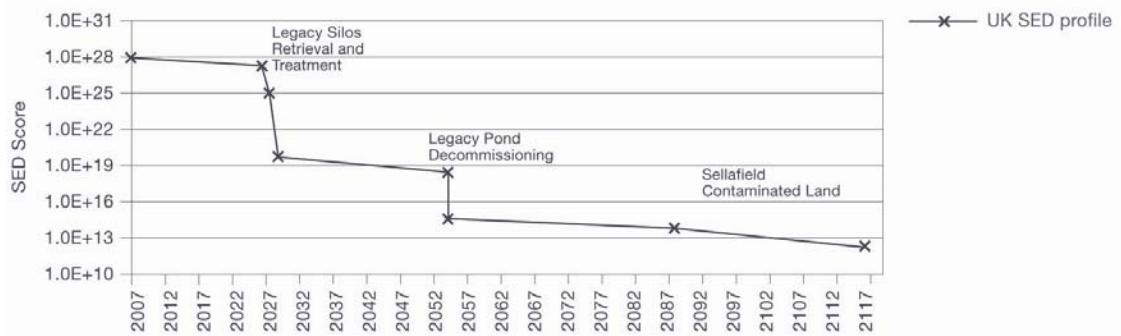
SLCs are required to calculate SED scores for facilities on their sites and to demonstrate the SED reduction achieved by their baseline plan projects and activities. This requirement is now part of the NDA hazard baseline process⁹ and is incorporated into Lifetime Plan (LTP) requirements for each NDA site.

The SED scores have now been combined to depict the overall level of hazard and how it will reduce over time as calculated in the various SLCs LTPs. The facilities that present the greatest hazard are at Sellafield and the impact of their clearance is shown by the key milestone markers in Figure 5.

⁸ <http://www.nda.gov.uk/documents/upload/EGPR02-NDA-Prioritisation-Procedure-Rev4.pdf>

⁹ http://www.nda.gov.uk/documents/upload/EGG_06_Hazard_Baseline_Specification_rev_1.pdf

Figure 5 – Indicative National SED Curve showing reduction in level of concern over time

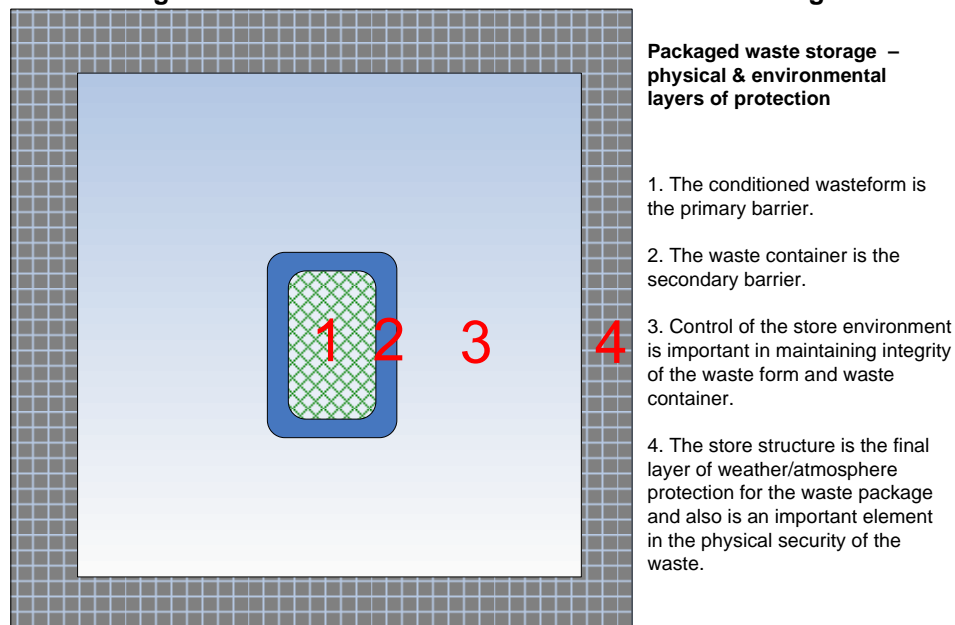


1.5.3 The need for interim storage

Interim storage is an essential component in the safe management of HAW pre-disposal, where waste should be stored according to the principles of passive safety.¹⁰ An interim store for packaged ILW, suitable for geological disposal or long-term storage, is a robust engineered facility with a design life of typically 100 years (as required for new stores by the Government’s response to CoRWM Recommendation 2), and resistant to foreseeable incidents such as seismic events and severe weather. Furthermore, an interim store system should provide protection for waste packages from potential external corrosion by ambient air caused by atmospheric salts, temperature and humidity levels, which could have a long-term impact on the integrity of the package. In terms of containment of radioactivity and prevention of releases which could impact upon the outside environment, a number of barriers and environmental controls are provided as listed below and illustrated in Figure 6;

- the wastefrom itself;
- the container;
- shielding (either of the package directly to varying degree or of the store structure);
- the external store structure.

Figure 6 - Multi-barrier features of interim waste storage



¹⁰ HSE document, Safety Assessment Principles for Nuclear Facilities, 2006 Edition, Rev 1, see paragraphs 666 – 677.

Waste packages are shielded to reduce external radiation. This means the areas outside modern engineered stores avoid the need for classification as controlled access areas. From a waste management perspective the balance of these engineered barriers is normally focussed on the waste form, then the container and finally, the store. The store itself should be given limited credit for control of the risk and hazard, because it represents the final barrier between the waste and the environment. The store structure is a barrier against intrusion and hence performs a security role. Monitoring and inspection of waste packages is a key measure of the performance of these multi-barriers. Appendix 2 provides a detailed overview of safety requirements for interim storage.

NDA's RWMD has prepared a report entitled 'An Overview of Storage Strategies for Radioactive Waste'¹¹. The report (initially commissioned by Nirex¹²) considers the general requirements for interim storage as part of an integrated waste management strategy, with reference to international experience and currently operating stores. The report distinguishes between interim storage of packaged wastes awaiting disposal (for operational timescales in the range 100-300 years), and long-term indefinite storage. The impact of interim storage is addressed from the point of view of management arrangements, environmental impacts, costs, social and ethical issues, societal stability, natural events and the possibility of abandonment. Of particular relevance to this waste storage review are the conclusions on technical requirements for assurance and integrity that need to be met if interim stores are to be given recognition as playing an assured part of a robust waste management strategy. Key engineered systems that need to be maintained include the structural components of the stores, their active ventilation and filtration plant, physical security and controls on environmental conditions within the stores.

In terms of a robust interim storage position the following will need to be considered:

- Plans for the retrieval and conditioning of HAW currently held in historical storage facilities and if necessary, waste packaging for disposal or long-term storage may be achieved in a staged approach.
- Identifying the key issues and risks associated with packaged wastes in storage and ensure mitigating actions are in place.
- Understanding the relevant key decision points and their impact on the interim storage programme including GDF implementation and potential store replacement dates.
- Ensuring waste transport is an integral part of the interim storage programme.
- Flexible approach to waste management that can accommodate various disposal timeframes, waste volumes and packaging concepts.

By following this approach progress with hazard and risk reduction can be monitored recognising its high priority status for the industry. Conditioned wastes are placed into storage, where there are no short term issues, and the longer-term performance concerns are being addressed by the sites. Furthermore, the export of waste to the GDF is not sensitive to its availability and there is appropriate contingency in place that addresses any significant programme delay.

1.5.4 Reactor decommissioning

The current policy for decommissioning of Magnox and AGR reactors is to follow what is known as the 'Safestore' concept, which is a three stage process.¹³ To date HSE Nuclear Installations Inspectorate (NII) have not yet assessed a safety case for a reactor under the Safestore regime, so this is as yet an untested approach in the UK.

¹¹ NDA/RWMD/002, Overview of Storage Strategies for Radioactive Waste

¹² Nirex - Nuclear Industry Radioactive Waste Executive

¹³ Review of Radioactive Waste Management Policy: Final Conclusions, (Cm2919), HMSO, 1995.

These stages start with removal of the fuel followed by 'Care and Maintenance (C&M) preparations' where operational wastes are recovered, conditioned and transferred to the engineered store. Redundant ancillary facilities are removed. This stage removes approximately 99% of the radioactivity from the site.¹⁴ At the end of this phase the reactor buildings are secured against the weather and intruders.

The second stage is known as C&M where the site could remain in a quiescent state for a century or more with only routine monitoring and surveillance required.

The third stage sees the dismantling and complete removal of the Safestore buildings returning the site to an End State agreed with local stakeholders. Within the site LTPs this process is known as Final Site Clearance (FSC). FSC for Magnox sites is currently planned to begin towards the end of this century. During FSC operations a large amount of ILW will arise mostly in the form of graphite, concrete and steel. These ILW reactor decommissioning wastes were specifically highlighted by CoRWM, recommendation 8, which stated; *'In determining what reactor decommissioning wastes should be consigned for geological disposal due regard should be paid to considering other available and publicly acceptable management options, including those that may arise from the low level waste review'*. Government accepted this recommendation.

1.5.5 Minimising the need for waste storage

NDA's priority is early immobilisation of operational and historical waste materials to reduce the safety and environmental risk they pose. Once packaged, wastes need to be placed into appropriate interim storage until a disposal route is available. However, NDA is keen that decommissioning schedules recognise the need to avoid 'double handling' of waste packages. As a general principle it is better if waste produced can be consigned directly to disposal rather than being placed in interim storage, as this reduces cost of having to construct interim stores (and subsequent store decommissioning) and prevents 'double-handling' of waste packages. NDA expects waste producers to support this approach by minimising the need for interim storage unless there are safety, environmental or other drivers requiring it, for example, the poor condition of an ageing facility or gaining access to contaminated land to allow remediation and reduced risk of groundwater contamination.

1.6 The current plan

Over the next two decades NDA sites are carrying out retrieval and treatment programmes for historical and operational wastes arising on existing facilities. By 2040, when current NDA plans anticipate that the GDF could be available, it is anticipated that the vast majority of these wastes will be in a packaged form, stored in modern interim storage facilities and ready for disposal. As of the 31st March 2008, approximately 22,000 m³ of waste had been recovered, conditioned, packaged and placed into interim storage (see Figure 7). This volume comprises around 44,000 individual waste packages and represents approximately 8% of the total reported ILW in the 2007 Inventory. These packages have all been issued with Final Stage Letters of Compliance (LoC).¹⁵ Dialogue between NDA RWMD and Licensees on waste packaging is regular and ongoing. Priorities for waste treatment are established through the site LTPs, and a programme for seeking endorsement through LoCs is maintained, with pre-bookings for RWMD assessment being made up to 18 months in advance. Legacy and operational wastes have tended to be prioritised over decommissioning wastes. Those HAWs not packaged and in appropriate storage facilities are expected to be *in-situ* within facilities (such as reactor cores) ready for decommissioning.

¹⁴ Chapter 6, 'Reactor Decommissioning – The Safestore Concept', Nuclear Decommissioning, Waste Management and Environmental Site Remediation, C R Bayliss, K F Langley, Elsevier, first published 2003.

¹⁵ NDA Report number, NDA/RWMD/MD008, 'NDA interactions with Waste Producers on plans for packaging radioactive wastes'.

Figure 7: Status of ILW (2007 UK Inventory, conditioned waste volumes)

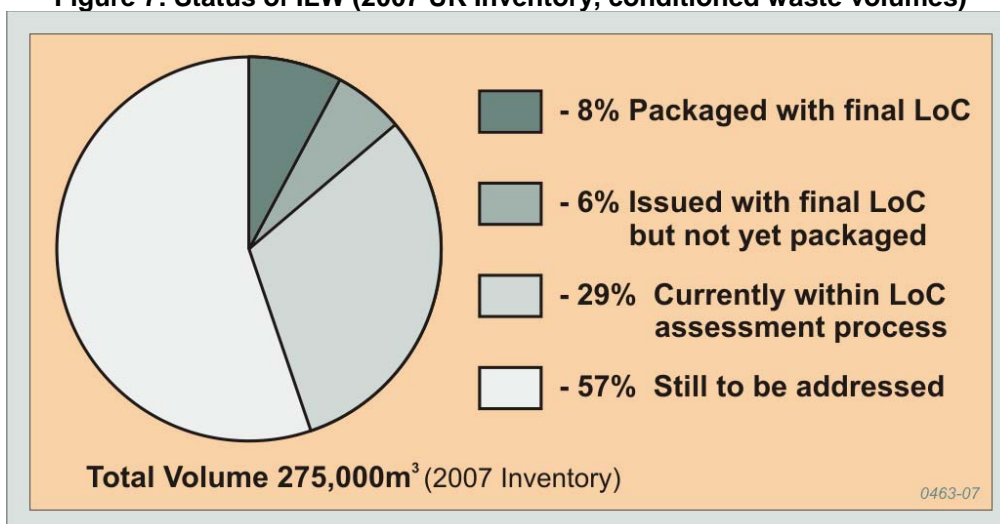


Table 1 - Waste predicted to be in storage at 01 April 2040 and overall estimate of quantities to three significant figures (2007 National Waste Inventory)

	ILW - m ³ packaged volume	HLW - canister numbers	HLW ¹⁶ - m ³ packaged volume
Conditioned waste in store at 01/04/2040	195,000	7,700	7,400
Total UK Inventory	387,000	7,700	7,400

Note – HLW **only** exists at Sellafield

1.6.1 Package performance

Package performance is a key consideration for assessing the lifetimes of packaged waste. For waste packages holding a LoC, the conditioned waste form itself and the container (most but not all waste containers are currently manufactured from stainless steel) will ensure the package will be suitable for transport and disposal in line with current timescales, provided the waste package is cared for in the manner specified when the LoC assessments were undertaken.

The LoC is issued by RWMD in its role as eventual operator of the GDF. It is envisaged that the LoC assessment process will eventually be replaced by a waste acceptance process by which waste packages are assessed for compliance against the actual safety cases for transport, emplacement and eventual disposal in the GDF. An example of the steps involved are shown in Figure 8.

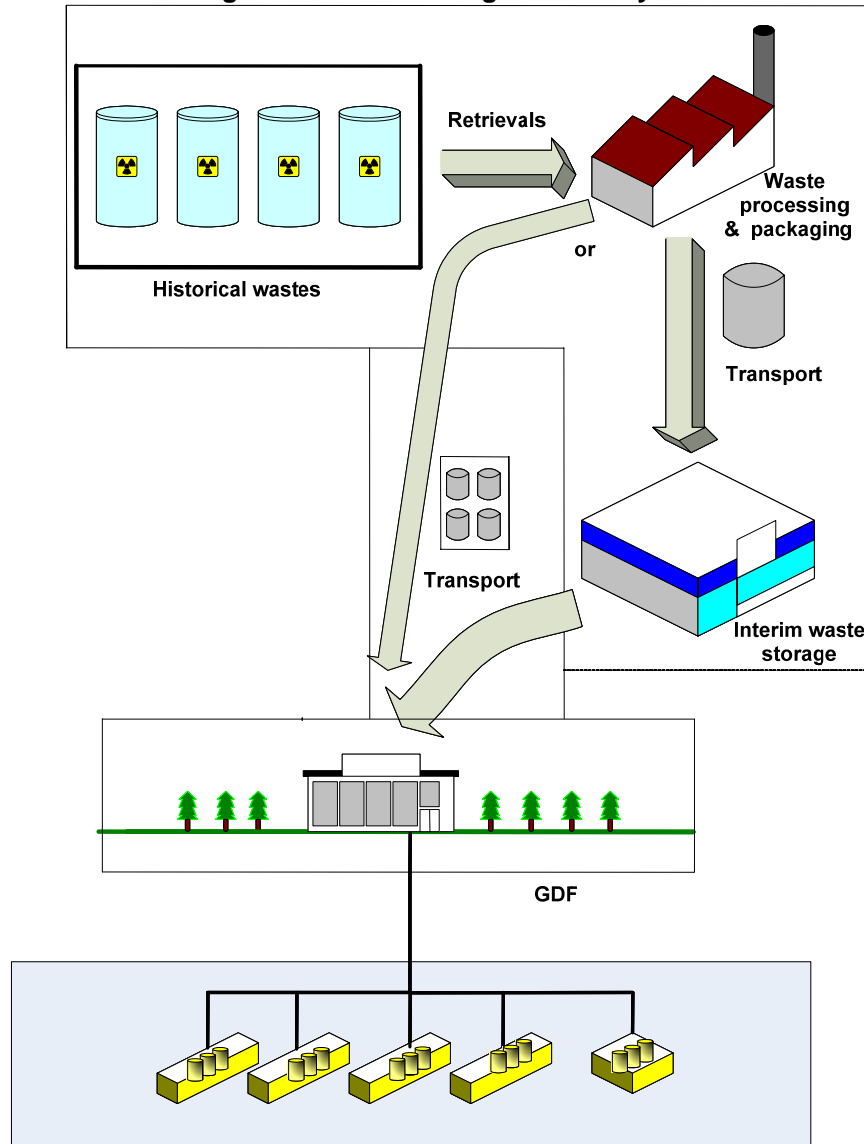
The LoC and the underlying assessments will be used by the SLC in the development of the proposed Radioactive Waste Management Cases.¹⁷ This is the overarching documentation that details the proposed lifecycle management of the waste and sets out the associated justification in safety and environmental terms. In support of this ongoing joint guidance, the first technical guidance modules were published in November 2008 for trial use including, ‘Waste minimisation, characterisation and segregation’ and ‘Managing information relating to radioactive waste in the United Kingdom’.¹⁸

¹⁶ Assumes HLW is packaged in a metal disposal canister similar to the concept proposed in Sweden. This data is draft work in progress and is subject to change.

¹⁷ The management of higher activity radioactive waste on nuclear licensed sites. Part 1. The regulatory process. December 2007, HSE, EA, SEPA.

¹⁸ See <http://www.hse.gov.uk/nuclear/wastemanage.htm> for further details.

Figure 8 - Waste management lifecycle



Even where waste packages are in receipt of a LoC, there will remain some uncertainties regarding their evolution during the period of interim storage. This may particularly be the case where waste streams contain relatively large amounts of chemically reactive species such as metallic Magnox, aluminium and uranium. These materials are likely to continue to corrode, even when conditioned into a final waste form, leading to hydrogen generation and the formation of corrosion products, which may lead to an expanded or distorted waste form. This potential behaviour has been flagged during LoC assessments influencing specifications that seek to minimise this effect by either limiting the water content of the conditioning matrix (often cement grout) or by limiting the mass (or surface area) of reactive metal per package. In some cases this has been addressed through a caveat when a LoC is issued. This could take the form of a requirement for the operator to keep this issue under review and carry out additional research and development on this important area of concern. This may also be the case should there be any deviations from an agreed LoC.

If the expected interim storage timescales are extended, the probability of a waste package requiring remedial work will increase. Remedial work could range from simple repairs to overpacking to complete repackaging.¹⁹ Therefore such actions could be costly, especially if it involves complete repackaging of the waste, and would have a direct impact on a site's LTP costs. More importantly there are safety and environmental implications, as waste products will be doubled-handled and any repackaging will lead to an increase in overall waste volume (both from the primary process and decommissioning of any new asset). Appendix 3 gives a more detailed overview of package performance.

1.6.2 Integrated waste strategies (IWSs)

NDA requires its SLCs to produce Integrated Waste (management) Strategies for their sites. These are used to help deliver decommissioning and clean-up work and are expected to identify the challenges and solutions to dealing with the waste throughout the whole lifetime of the site.

The IWS documents in turn help the NDA to identify the important issues that need to be resolved and critical facilities that need to be developed or protected. The NDA then takes a multi-site or national view to see how similar problems could be solved collectively, for example by:

- Sharing research and development.
- Innovation.
- Waste treatment facilities.
- Sharing good practice and lessons learned.

Decommissioning and clean-up strategy is heavily dependent on having safe, environmentally responsible and cost-effective waste disposal routes. The timing and nature of decommissioning work will affect not only the amount of waste but also the ways in which it can be treated.

The NDA is looking for more innovative approaches to waste management that take into account the principles of the waste management hierarchy²⁰, which will reduce costs and the amount of waste produced for disposal. Waste volumes could be reduced through characterisation, sorting, separating, decontaminating, recycling and re-use of materials where practicable.

The waste producers are responsible for developing their own waste management strategies and for consulting the Regulators and disposal organisations. They must ensure that they do not create waste problems that cannot be resolved with current techniques or foreseeable developments in technology.

Waste producers are expected, where it is practical and safe, to characterise and segregate waste according to its physical, chemical and radiological properties. The preferred management regime should take account of the current availability and future prospects for disposal routes.

1.6.3 Transport of wastes

At the end of the interim storage period it is the responsibility of the waste producers to ensure that the package is safe for export off-site and is compliant with Transport Regulations in force at that time. Assessments for the LoC process also address transportation so packages in receipt of a LoC should have increased confidence that transportation issues have been addressed.

¹⁹ Environmental Agency, 2005. Feasibility and implications of Reworking Intermediate Level Radioactive Waste Packages. Science Report Sc040067.

²⁰ See <http://www.nda.gov.uk/documents/upload/WNM-PP-001-The-role-of-the-waste-hierarchy-March-2008.pdf>,

The Dangerous Goods Division of the Department for Transport (DfT) is the safety regulator for transport of all categories of radioactive waste. The minimum requirements of the DfT are summarised below.

- The packaging²¹ must be manufactured so that it meets the regulatory performance criterion at the time of production.
- **At the time of transport the waste package** must meet the transport regulations of the time, which may be decades after loading the package and as a consequence, may be subject to changes in legislation.
- The transport package must be appropriately identified, marked and labelled.
- Records must be available at the time of transport.
- The consignment must meet the regulatory requirements in force at the time of the transport.
- The storage environment must be controlled and appropriate to the packaging to avoid degradation over extended storage periods.
- Pre-despatch inspections may be required to enable the containment and mechanical integrity of the package to be demonstrated.

Many ILW and HLW waste packages will require transportation meeting International Atomic Energy Agency (IAEA) 'Type B' packaging standards in order to meet DfT requirements. This means that the waste packages will be overpacked into a shielded transport container. NDA RWMD is developing such a transport container, which will be approved by the competent authority before coming into service. The Standard Waste Transport Container (SWTC) is designed around the existing NDA RWMD disposal waste packages which are already in use. Other waste package types which are transport packages in their own right²² will be self-certified by the waste packagers. Both transport options require the consignor to demonstrate that the transport package has been developed under a suitable quality management system and that the wastes being transported are compliant with the transport package safety case.

Assurance of compliance with the transport regulations in force at the time of disposal will be dependant upon:

- A set of transport regulations that is accessible and understandable in the context of bulk ILW transport (noting that current regulations are aligned to the transport of LLW, spent fuel and small consignments such as sealed sources).
- A set of national requirements intended to ensure that waste is managed in a consistent manner and is adopted throughout the industry.
- Appropriate training regimes are adopted.
- The adoption of effective and appropriate quality assurance programmes;
- An effective enforcement regime.

Using unshielded packages maintains a flexible approach to transport, as there will always exist the opportunity to redesign the SWTC. The RWMD transportable waste boxes were designed with a margin to permit provision of a future overpack and to remain in the rail gauge should future regulations permit.

The operation of the transportation system for movement of waste packages from the modern HAW store locations to the planned GDF will be a major undertaking. As an example, the expected annual movements involved are likely to be more than 10 times those seen for spent fuel movements to Sellafield. NDA is planning on the basis that the transport system will be centrally coordinated and make use of dedicated rolling-stock, road vehicles and transport containers. Transport infrastructure and safety case issues are also being investigated, including use of sea transport.

²¹ In many cases for ILW and HLW, the waste package will be overpacked in a re-usable shielded container for transport, the overall assembly being termed a "transport package" or "packaging". Some lower activity wastes may be conditioned into waste packages that are transport packages in their own right.

²² Industrial (IP-2) and Type A packaging designs

Before waste packages can be transported off-site it must be confirmed that they will be (i) accepted at the destination facility, and (ii) be compliant with the safety case for transport:

- (i) Acceptance. It is planned that the GDF operator will issue Waste Acceptance Criteria (WAC) based on the safety cases for the facility. These are expected to be developed from the existing waste package specifications and packages holding a LoC should be expected to achieve compliance. Before transport, checks will be undertaken to confirm that waste packages are compliant with the WAC. Regulators have a role to ensure that stored waste packages are compliant with the store safety case and are evolving in the manner predicted.
- (ii) Transport safety. Each transport package type will have a safety case (Design Safety Report (DSR)) and before transport it will be necessary to demonstrate compliance with this. RWMD is undertaking development of the transport containers and associated DSRs to give confidence that proposed waste packages will be transportable.

Currently only Harwell and Winfrith assume sole use of road transport to the GDF and only Sellafield assumes sole use of rail transport. All other sites assume some combination of road transport to an off site railhead. RWMD is also investigating the use of sea transport, although this too is also likely to involve combination of road and/or rail.

1.6.4 Waste emplacement and storage in the geological disposal facility

The waste package will be checked and shown to comply with the disposal facility WAC before it leaves the waste producer's site. Any remedial work found to be necessary to bring the package into compliance will be carried out by the site operator before despatch. The final WAC will be developed from the actual design and safety cases including site licence and authorisation for the GDF, in line with joint regulatory guidance on the management of HAW.²³

Packages are also expected to be subject to checks on receipt at the GDF. As a minimum this will involve visual inspection and checking the package unique identifier against acceptance paperwork.

Following emplacement underground the GDF will provide facilities for the continued monitoring of waste packages during the operational phase in line with the requirements for the Environment Agency and HSE (NII). The detailed inspection regime will be developed in line with the facility design and safety cases.

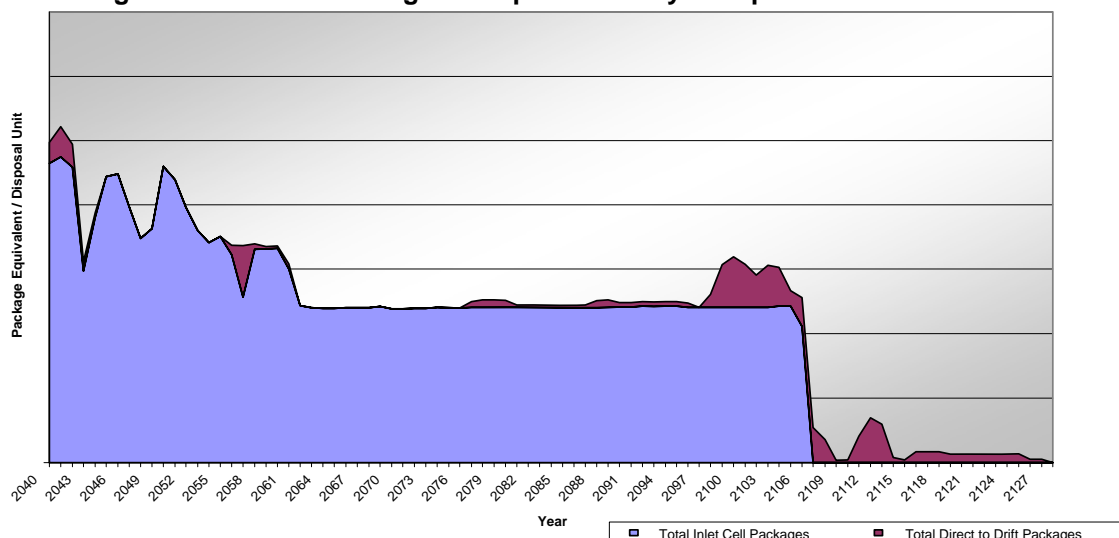
1.6.5 Geological Disposal Facility (GDF) scheduling

The GDF is assumed to be available from 2040 for ILW and from 2075 for HLW. Current GDF scheduling and LTPs throughout the industry are based on these assumptions. The NDA recognises, however, the possibility highlighted by CoRWM that a GDF may be delayed beyond this point. According to CoRWM Recommendation 2, interim storage should account for such delays and consider storage periods of 100 years or more.

Another factor which needs to be considered in relation to interim storage is the length of time it will take to transfer all the waste to the GDF. It is impossible for all HAW to be exported to the facility at the same time. This will mean that the transport process will have to be planned and scheduled. It is expected to take many decades to move it all. According to current plans, it will be the end of this century and beyond when waste from the major decommissioning programmes and FSC programmes will arise. A schematic overview of the GDF receipt schedule is shown in Figure 9 on the next page.

²³ <http://www.hse.gov.uk/nuclear/wastemanage.htm>

Figure 9 – Current Geological Disposal Facility receipt schedule for ILW



1.6.6 Security

The Office for Civil Nuclear Security (OCNS) is the UK Regulator for security in the civil nuclear industry and is responsible for ensuring that the industry complies with the requirements of the Nuclear Industries Security Regulations 2003²⁴ (NISR 03). OCNS therefore ensures that all sites (NDA and private sector sites such as British Energy) comply with the requirements of NISR 03 through all waste management operations. Appendix 4 gives a more detailed summary of security arrangements in the UK.

1.6.7 Summary position

In summary, the general approach to HAW management is:

- Prioritise the retrieval, conditioning and passive storage of HAW currently held in historical storage facilities. Application of the NDA Prioritisation Process focuses attention onto such relatively mobile wastes thus reducing the hazard of waste materials.
- Minimise storage of HAW in raw form in line with good practice.
- Minimise the volume of ILW produced from decommissioning.
- Where possible, package HAW into a form that is compliant with the previously-Nirex specification, now held within NDA (subject to case-by-case assessment of suitability).
- Safe and secure interim storage pending availability of the GDF.
- Explore more innovative approaches to waste management that take account the principles of the waste management hierarchy.

1.7 NDA Strategy Management System²⁵

The Strategy Management System (SMS) is a management tool used by the NDA to develop, control and communicate its Strategy for decommissioning and cleaning up the UK's civil public sector nuclear sites. It also provides the basis for the periodic review of our Strategic Plan which summarises the current strategy at the time that it is published.

²⁴ <http://www.opsi.gov.uk/si/si2003/20030403.htm>

²⁵ See website, www.nda.gov.uk, for further details on the Strategy Management System

NDA's overall Strategy has been broken down into individual Topics that cover all areas of NDA's remit as defined in the Energy Act 2004. Each Topic will have its own strategy and is developed independently (at least initially). However it is recognised that some topics inevitably interact with and influence others, consequently we have grouped related topics together as Themes. Currently there are 27 Topics grouped into six Themes. The 12 Topics grouped under a theme called 'Critical Enablers' cover matters, which are crucial to the successful delivery of all the other topics.

Topic Strategies are developed in consultation with a broad range of stakeholders including Government, Regulators, other groups and individuals with a declared interest in the topic. The extent and nature of the engagement will depend on the topic concerned and range from requesting comments on proposals through to full engagement at key stages during strategy development.

The HAW Topic Strategy is the most relevant to this Storage Review and the key outputs and proposed way forward will be closely considered by the NDA. The scope of the HAW Topic Strategy will cover the related Business Plan and NDA Strategic objectives with a keen focus on the effective application of the waste management hierarchy. To help address the HAW waste management lifecycle a number of lower level Topic Strands are being developed that account for the major waste stream areas.

Chapter 2: ILW storage optimisation opportunities for NDA Sites

This chapter covers NDA's strategy commitment to investigate opportunities for optimisation of the number of ILW storage facilities for the period prior to a GDF becoming available. This scope excludes the large volumes of waste generated during Magnox FSC activities which will be consigned straight to disposal. Four indicative storage options have been described in order to provide a focus for assessment and discussion with stakeholders. It is noted that this work was carried out during 2006 and 2007 and the original assumptions should be revisited as part of any forward programme of work.

2.1 Background

The current baseline position for Magnox is that the operational ILW under consideration will be conditioned for interim storage, and an ILW store will be constructed on each site. The southern England UKAEA sites also assume that any ILW arising from operations and decommissioning at Harwell and Winfrith will be conditioned for interim storage, and an ILW store will be constructed on each site.

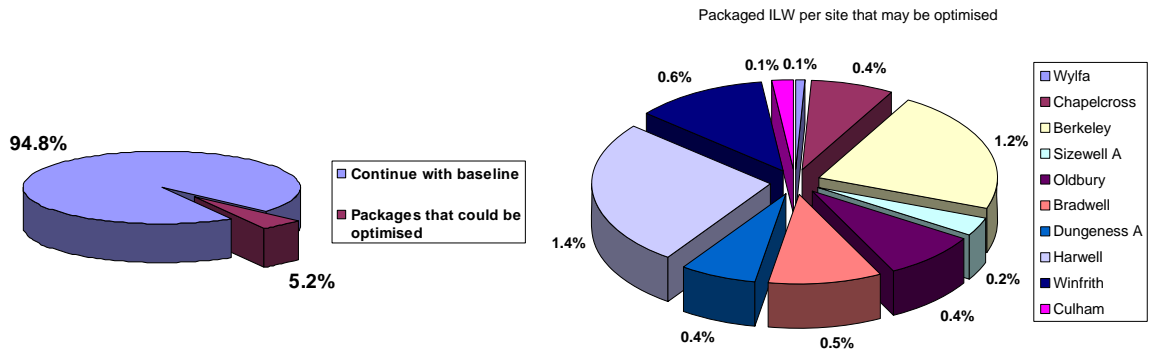
Theoretically there should be benefits from consolidating waste storage rather than building individual stores at all of the sites where ILW is produced. For example, avoiding the construction of stores at some sites should reduce construction activities, capital cost and subsequent security costs. On the other hand transfers between sites would bring in new transport costs and issues of local stakeholder concern. In 2006 and 2007 NDA, supported by Magnox South and UKAEA, carried out a review of opportunities to optimise the interim storage of packaged ILW and has assessed possible strategic options for optimising interim ILW storage at NDA sites.

Assumptions to help the initial option assessment work have been set out:

- The current baseline for stores for conditioned ILW should be pursued at the following sites: Dounreay, Hunterston A, Sellafield (including Calder Hall & Windscale), Trawsfynydd, Hinkley Point A.
- Currently there is no ILW at Capenhurst and Springfields, so these sites were excluded from consideration at this stage.
- Volumes of wastes quoted use LTP 2006 data.
- Magnox reactor decommissioning wastes that will be produced during FSC may not be interim stored, and should not be produced unless the disposal route is open.
- Any new store would be on a current nuclear licensed site (the optioneering work described here only focuses on NDA sites). A large new national 'greenfield' site would represent an unnecessary and unrealistic option.
- Package types are as assumed in the baseline, e.g. 500 litre drums, three cubic metre drums and/or boxes.
- Existing/ongoing ILW storage activities should not be disrupted.
- Non-NDA waste producers, e.g. BE, are not included within this original storage optimisation study.

There is limited scope to affect the overall ILW interim storage position because the proportion of ILW disposable units (one unit is a 3 m³ box, 3 m³ drum, 2 m box, etc) that might be affected by the application of alternative options is only about 5% of the total ILW interim-stored inventory for NDA sites. Figure 10 summarises this position including a site-by-site breakdown of the waste packages by overall percentage numbers.

Figure 10 - Packaged ILW suitable for optimisation



There is theoretical scope for revised/optimised ILW storage at the following ‘southern’ sites: Oldbury, Sizewell A, Berkeley, Winfrith, Bradwell, Harwell, Dungeness A, and Culham. Wylfa and Chapelcross are geographically separated from this group and have small quantities of ILW. It is therefore considered to be appropriate to investigate local opportunities for these sites, *i.e.* transfer their wastes to a nearby site with substantial ILW stores rather than consider them in the context of a wider strategy for the southern sites.

2.2 Proposed options for storage optimisation of conditioned ILW

In addition to the current baseline position (Option 0) four indicative storage options have been described in order to provide a focus for assessment and discussion with stakeholders.

Option 0 – current baseline plan. ILW Stores built at Sellafield and Dounreay. A local ILW Store at each Magnox Site plus separate stores for Culham, Harwell and Winfrith ILW.

Option 1 – Local site-to-site approach. Work to date has highlighted the opportunity to put more focus onto waste storage optimisation capable of being realised at a more local level. That is, useful spare capacity may exist in the stores that NDA are already building or planning to build in the near future.

Option 2 – Packaged wastes from up to eight sites to be consolidated at a single NDA site in southern England. Could include one or more stores at the chosen site.

Option 3 – Packaged wastes from up to eight sites to be consolidated at two NDA sites in southern England. Perhaps ‘east’ and ‘west’ as one of several possibilities.

Option 4 – Centralised approach – Packaged wastes from up to eight sites to be consolidated at Sellafield

These initial high level options have been discussed with stakeholders *via* the Waste Issues Group, which was a sub-group of the NDA’s National Stakeholder Group. As this work was carried out during 2006 and 2007, the proposed strategic options should be reviewed as part of any forward programme including the declared current assumptions.

2.3 Findings

Taking into consideration the proposed options for storage optimisation of conditioned wastes, the following findings were highlighted:

- There are a number of opportunities being explored by Magnox that could reduce the packaged volumes of operational ILW by a significant margin. If these waste minimisation programmes are successful then there could already be enough capacity within the existing and planned Magnox ILW stores to accommodate Magnox operational ILW volume together with southern UKAEA three cubic metre boxes and 500 litre drums (unshielded packages).
- The quantity of ILW that might be amenable to revised interim storage arrangements is only approximately 3,600 packages. This should be viewed in the context of the capacity of a typical Sellafield store (more than 6,000 packages) and a planned typical Magnox site ILW store (1,000 packages) for example. There is no question of huge new stores being needed.
- All sites should consider separately those ILW materials that may be suitable for decay storage and ultimate disposal at a LLWR.
- Harwell, Culham and Winfrith should consider the possibility of storing their ILW at more than one location.
- Option 4 (consolidate at Sellafield) may have little potential because of the local planning presumption²⁶ against waste import (unless national interest and BPEO).
- NDA has no intention of pursuing a radically altered waste storage regime such as a single very large low maintenance UK facility.
- Overall cost savings linked to reducing the actual number of stores is relatively low. Wider benefits could be secured by pursuing an 'integrated waste management' approach that considers waste recategorisation, waste processing and volume reduction, waste packaging and alternative storage concept opportunities.

2.4 Way forward for Storage Optimisation

2.4.1 Near term NDA objectives

Taking into account the above observations it is proposed that the short term position for pursuing ILW storage optimisation opportunities is as follows:

- Stakeholder engagement is seen as a key activity throughout the detailed optioneering programme
- NDA should continue to encourage waste minimisation and decay storage opportunities available to SLCs to help reduce overall NDA liability, *i.e.* reduce the overall number of ILW packages (and potentially ILW interim stores), and thus increase storage flexibility.
- The main focus of investigating storage optimisation opportunities for NDA ILW should be southern Magnox and UKAEA sites.
- The current baseline plans for ILW stores should be pursued at the following sites: Dounreay, Hunterston A, Sellafield (including Calder Hall and Windscale), Hinkley Point A and Trawsfynydd.
- Local site-to-site opportunities could be investigated for the relatively small quantities of Chapelcross and Wylfa ILW.

²⁶ <http://www.cumbria.gov.uk/eLibrary/Content/Internet/538/755/2146/389021340.pdf>, p4.

- Opportunities for waste consolidation could be pursued for five Magnox sites (Oldbury, Berkeley, Dungeness A, Bradwell, Sizewell A) to consolidate ILW at NDA sites with an existing or committed store (relevant if volume minimisation initiatives free up capacity) or to transfer ILW to a separate regional store located at one of the NDA sites with an existing or committed store.²⁷
- UKAEA could be encouraged to pursue opportunities for three sites (Harwell, Winfrith, Culham) to consolidate 'Magnox store-compatible' ILW at sites with existing or committed stores or to transfer ILW to a separate regional store located at one of the sites with existing or committed stores. A further opportunity could be to have a single, or more than one, ILW store at one of the UKAEA southern sites. A separate solution is needed for 'non-Magnox store-compatible' packages.
- Any storage optimisation process solution will involve the transport of waste from one location to another and transport must be seen as a key enabler, *e.g.* the availability of waste transport containers.
- There may be opportunities to extend the study to include other waste owners for example, it may be reasonable to consider a single ILW store for co-generation BE/NDA sites.

An overall 'integrated schedule' should be developed that considers the waste minimisation, alternative waste packaging options, stores construction and stakeholder engagement programmes. The plan should also highlight key critical tasks such as:

- The licensing of transport containers.
- Key technical, safety and environmental impact studies.
- Regulator interface timelines for approval of the waste minimisation activities and any proposed intersite transfers of waste.

Magnox are now taking the lead in developing this programme for the southern UK sites recognising that 2013 would be the earliest insertion point for change in strategy based on the fact that significant stakeholder engagement will be required. The original assumptions for the initial optioneering study should also be reviewed as part of this programme including the outputs of any innovation work, *e.g.* alternative waste packaging and treatment opportunities.

2.4.2 Longer term objectives

It is recognised that whilst this study was being prepared the Scottish Government did not endorse the 2007 Managing Radioactive Waste Safely White Paper, as it did not support a policy of deep geological disposal for higher activity radioactive wastes. The Scottish Government policy is for near surface, near site long term storage for these wastes. The NDA is working with the Scottish Government as it develops its policy and the options and issues identified in this report will be considered in that process.

This optioneering study reviewed the baseline position and did not take into consideration early alternative storage options being considered by the SLCs. For example, Magnox South are actively pursuing a variant option for ILW storage ('Ministores' concept), which may enable a reduction in the current ILW management programme timescales and coupled with waste minimisation activities could potentially lead to savings against the baseline costs in the near to medium term. It should be noted that the Ministores project is still in progress and the outputs will be considered should a case be made by the Storage Optimisation Programme, as it moves forward from this current stage.

²⁷ The possibility of consolidating ILW at Sellafield needs to be addressed within this, while recognising the possible problems with this solution noted earlier.

Chapter 3: Interim Waste Stores in the UK

This chapter describes the methodology followed during the review and gives an overview of the findings of the review.

Between October 2007 and March 2008 the NDA collected and analysed information on existing and planned interim waste stores in the UK. A summary of the main findings is set out below. Data tables for each site are given in Appendix 4 and should be considered in conjunction with the text in this section. All dates and plans given are based upon LTP 2007, as this was the most up to date approved information available at the time of the Review. As a consequence this information is likely to change as LTPs are updated. Additionally, some SLCs are working on potential changes to their storage plans. However as these innovations are not yet developed into baseline plans, they are not included in this review. The Scottish Government policy decision to adopt long term storage, rather than geological disposal, is also not yet reflected in LTP's and hence not included within the data contained in this chapter.

All of the information on the storage facilities was provided by the licensees, and NDA acknowledge their support in this.

The terminology used in the data tables in Appendix 4 and throughout this section is defined below:

- Original/notional design life – the period of time for which the store was designed to operate.
- Start of operation – the date at which the store started operations (i.e. when first received waste).
- Present baseline end of operation – the current planned date at which the store has been emptied of waste and is ready for decommissioning (based on LTP 2007).
- Present baseline service life – the number of years for which the store holds waste (based on LTP 2007).

3.1 NDA sites

A number of Key Performance Indicators (KPI's) from the current NDA Business Plan 2008-2011²⁸ have been reproduced relating to ILW and HLW waste under the appropriate site description.

3.1.1 Sellafield

Sellafield, located in Cumbria, has an area of 262 hectares covered by the nuclear site licence. It is a large, complex nuclear-chemical facility that has operated since the 1940s, and has undertaken work for a number of organisations from the UK and overseas. Operations at Sellafield include processing of fuels removed from nuclear power stations; Mixed Oxide (MOX) fuel fabrication; and storage of nuclear materials and radioactive wastes. The site is licensed to Sellafield Ltd who operate it on behalf of the NDA.

²⁸ <http://www.nda.gov.uk/documents/loader.cfm?url=/commonspot/security/getfile.cfm&pageid=19286>

The NDA's Business Plan for 2008/09 requires the following KPIs from Sellafield Ltd:

- To enhance the security arrangements to the Highly Active Liquor Evaporation and Storage (HALES) and historical plant areas.
- To continue the Magnox storage pond skip handler refurbishment to facilitate retrievals.
- To prepare for the first return of vitrified HLW to its country of origin.

3.1.1.1 Historical waste storage facilities

The Magnox Swarf Storage Silos at Sellafield currently hold the highest SED score of all of the facilities across the NDA estate. The high SED score is due to the age and condition of the facility, the form of the material stored, the volume of material stored and the radiological and chemical hazard potential. However, the scheduled removal of this material, its conditioning and relocation to a purpose built, modern engineered store also achieves the largest decrease in SED score across the NDA estate.²⁹ The SLC is working with NDA's RWMD through the LoC assessment process to develop a conditioned waste package that provides for both passive safety and disposability when judged against RWMD's plans for geological disposal.

The Pile Fuel Cladding Silo is another facility with a high SED score on Sellafield site. Removal of its waste to a purpose built, modern engineered store will also achieve a significant SED score decrease. This waste is proposed to be recovered from the Silo and loaded into interim storage boxes in an unconditioned form pending the development and availability of a final conditioning route and therefore will be defined as 'Waste in Process' by the NDA's Hazard Baseline project (see Appendix 1). Whilst some hazard reduction is achieved by relocating the waste into robust containers the most significant benefit is the reduction in risk due to containerisation and the emptying of the old facility.

Some historical waste streams pose significant technical challenges due to their inherent variability and sometimes uncertain contents. Proposals to condition wastes and produce waste packages are considered on a case-by-case basis through application of the LoC assessment process, ensuring that challenges are identified and appropriate packaging solutions are developed.

The first generation Magnox Storage Pond contains a significant inventory of miscellaneous beta-gamma contaminated waste, uranium bearing sludges and fuel debris. The sludge and debris will be recovered from this historical facility and stored in the Sludge Packaging Plant tanks as an interim measure pending final conditioning. The miscellaneous beta-gamma waste will be processed and products from both treatment processes will be compatible with RWMD disposability criteria and will be stored in specifically designed engineered stores. Again the relocation of this waste achieves significant risk reduction.

²⁹ Licence instrument 326a, issued by the NII in 2000, requires the bulk of the inventory to be retrieved by 2020 and the residuals to be retrieved by 2027

3.1.1.2 Existing modern engineered stores

Table 4 in Appendix 4 summarises all of the existing and planned engineered interim stores on the Sellafield site. It should be noted that the existing operational interim stores were designed with a typical lifetime of 50 years, as a GDF was then expected to be available around 2012.³⁰ A number of the existing engineered stores at Sellafield are currently scheduled to operate for longer than originally intended. There is just one exception to this, an operating engineered drum store which has a quoted design life of 100 years. The SLC has reported that it should in most cases, be possible to extend the operational lives of these stores to 100 years. However, these projected life extensions are only based on desk-top studies and require further engineering validation. Each of these positions is subject to ongoing safety case reviews recognising that waste storage is a continuous programme of work. Assuming a 10 year programme for planning, design and construction phases for replacement engineered stores then major decision dates for Sellafield site will not begin until the late 2020s or early 2030s. The decision will need to consider the following:

- The current status of the GDF implementation programme, *i.e.* on-track, delayed or ahead of schedule.
- The current condition of the existing storage facility and the ability to extend the operational lifetime in-line with the site's baseline plan.
- A full range of alternative options to be explored, *e.g.* BPEO.

The engineered suite of plutonium contaminated material (PCM) stores at Sellafield contain both conditioned PCM waste in 500 litre drums alongside unconditioned 'raw' PCM in 200 litre drums, crates and stillages. This is not ideal due to the differing nature of the waste packages. However the site operator is required by the NII to demonstrate that this practice is safe through the store safety case and management procedures.

During planned inspections of waste packages containing Magnox swarf a small number of drums were found to have exhibited localised deformation. Further investigations have shown that the local deformations are caused by uranium pieces and future work programmes are aimed at understanding the corrosion mechanism(s), which may have caused the observed features and to quantify the number of drums potentially affected. These wastes have been processed since the early 1990s and had been assessed through the LoC process. The Nuclear Regulators and the NDA have been kept fully informed about the findings. Evidence to date indicates that a minority of Magnox swarf drums will exhibit local deformations and the drums are not currently giving rise to any undue safety concerns for continued safe storage.³¹

Sellafield Ltd design their store ventilation systems to meet a BNFL standard NF 0166/1 - Ventilation of Radioactive Areas, a Code of Practice which supersedes the previous Atomic Energy Code of Practice on Ventilation of Radioactive Areas.³² There are however some inconsistencies in the application of this Code of Practice across the site.

With respect to environmental controls within the stores it, has been noted that different approaches are being adopted across the site. For example, the earlier Engineered Drum Stores do not control temperature, humidity or chloride levels although the site is proposing to address these issues *via* its asset care programme. The asset care programme will identify if any store enhancements are required and the scope of any such enhancements.

³⁰ <http://www.hse.gov.uk/nuclear/nsn/nsn1397.htm#a6>

³¹ E&EPTC/09/020, 'Inspection of Encapsulated Magnox Waste Drums. Update – March 2009'

³² AECP 1054, Atomic Energy Code of Practice on Ventilation of Radioactive Areas

Across the Sellafield site there are different approaches to monitoring and inspection of packages in storage. The site is continuing to develop a standardised approach, particularly on the existing Encapsulated Product Stores and planned new stores, with monitoring and inspection arrangements for individual stores being developed and deployed based on the challenge posed by the waste form, *i.e.* a risk based monitoring inspection regime. It is suggested that such an approach to monitoring and inspection practices needs to be standardised across the site, and indeed across the UK, as a whole.

3.1.1.3 Future build engineered stores

A number of new HAW storage facilities are either currently under construction or planned for construction over the next 20 to 30 years. Sellafield's stores are designed to a '50 year + 50 year' design philosophy. This means that the civil structure of the facility has a design life of 100 years and the mechanical equipment has a design life of 50 years and can be refurbished and/or replaced.

3.1.1.4 Wastes requiring further consideration

The Sellafield Ltd LTP includes a work programme titled 'Final Conditioning and Disposal of ILW'. This covers the plans and costs for final conditioning of any remaining raw operational wastes on the site prior to disposal. It includes costs for the construction of new waste treatment facilities to condition miscellaneous beta-gamma waste and the graphite and stainless steel from AGR dismantling operations. It also includes costs for rework of any packages which are found to be in need of remediation prior to shipment off site for disposal.

3.1.1.5 Decommissioning waste

Some historical facilities even when emptied can still be regarded as relatively high hazard structures when compared to other facilities in the NDA estate. Sellafield's current plan is to decommission and consign packaged waste to the GDF directly after 2040. Prior to this date some decommissioning waste is stored in a suite of purpose built stores. A delay in the availability of this facility will result in a requirement for additional stores for decommissioning waste which is currently assumed to be exported directly to the GDF. Sellafield Ltd needs to ensure that this risk is adequately quantified and covered within the site risk register.

3.1.1.6 High level waste

There is a wide range in the age of the Highly Active Liquor Storage Tanks (HASTs). The volume of highly radioactive liquor which can be stored is controlled by a legally binding specification issued by the NII. Vitrification of HLW achieves significant hazard reduction. However, there have been issues with the Highly Active Liquor Evaporation and Storage (HALES) facility resulting in lower than anticipated vitrification throughput. This has occurred at the same time as reduced fuel reprocessing throughputs hence liquid HLW arisings have been significantly reduced. To deal with these issues Sellafield Ltd has started the design and construction of a fourth evaporator and has also provided scope for a further evaporator and replacement HASTs within the LTP.

The Vitrified Product Store planned operational life is shown to be 55 years beyond its design life. Sellafield Ltd intends to make provision for a replacement facility; however before a replacement store is commissioned, the site will investigate whether any operational life extension of the current store is possible.

3.1.2 Windscale

Windscale covers 14 hectares and is located within the Sellafield site in Cumbria. It comprises three reactors, two of which were shutdown in 1957. The third was closed in 1981. A fire damaged one of these reactors (Pile 1) in 1957, making its decommissioning a significant challenge. Windscale has now been amalgamated into the Sellafield site and a programme of work is underway to move to a single site licence for the combined site.

3.1.2.1 Existing and future build engineered stores

Table 5 in Appendix 4 gives the detailed information on the Windscale stores. The modern store at Windscale containing conditioned wastes from decommissioning of the Windscale Advanced Gas Cooled Reactor contains some of the lowest hazard wastes across the NDA estate. Other wastes in store at Windscale are housed within historical facilities which were not purpose built for ILW storage. However the quantity of material stored in these buildings totals less than 10 cubic metres and will be retrieved, conditioned and stored, alongside other Windscale Pile waste, in a new purpose built facility scheduled to be available in 2019. The majority of the capacity of this store will be taken up with graphite and residues from the 1957 fire which will be removed from the Pile core achieving a significant risk reduction. The graphite will be conditioned into three cubic metre boxes and placed in interim storage.

It should be noted that representatives from the Windscale site are working closely with Sellafield Ltd. to look at ways in which they could develop combined site Integrated Waste Strategies (IWSs) and LTPs. Current initiatives under review include the sharing of existing and planned stores on the Sellafield site and the use of shared conditioning facilities.

3.1.3 Dounreay

Dounreay is located in Caithness, Scotland and has a total site area of 55 hectares. It was established in the mid-1950s as a research reactor site with fuel production and processing facilities. There were three reactors, the last of which ceased operation in 1994. Dounreay is licensed to UKAEA (now Dounreay Sites Restoration Ltd (DSRL)) and, after Sellafield, is the second largest site in the NDA portfolio.

3.1.3.1 Historical wastes and existing stores

The liquor (raffinate) storage tanks are the highest hazard potential facilities on the Dounreay site. The Shaft and Silo are very much lower in terms of hazard. The shaft was originally authorised as a disposal facility in 1958 however its status has since been changed to one of 'storage pending removal of the contents'³³ and there is an agreed schedule of regulatory milestones which the SLC must meet. The shaft isolation project³⁴ is complete greatly reducing the amount of water entering the shaft and requiring discharge. There is also a slight reduction in risk. Waste from the raffinate tanks will be treated in both the Dounreay Cementation Plant and in a new remote handled ILW Immobilisation and Encapsulation plant. Details of the stores are provided in Table 6 in Appendix 4.

The current plan for Dounreay historical solid wastes is to retrieve and condition them into a disposable form. These disposable waste packages will be stored in three engineered ILW stores. The store connected to the Dounreay Cementation Plant contains conditioned raffinate from several of the storage tanks. The shaft and silo wastes will be conditioned in a new waste treatment plant and then transferred into an engineered interim store until transfer to the GDF.

³³ http://www.sepa.org.uk/pdf/publications/annual_report/9798/1997annualreport.pdf, p22

³⁴ The first phase of decommissioning the shaft involves isolating it from the groundwater that flows into the unlined shaft. Following public consultation, grouting of the rock fissures around the shaft was selected. This has involved building a raised working platform and drilling up to 400 boreholes around the shaft. Grout was injected through the boreholes to seal fissures in the rock creating a giant containment in the shape of a boot around the shaft, greatly reducing the amount of water that gets into the shaft.

Some of the 200 litre galvanised steel drums in the Dounreay Contact Handled Intermediate Level Waste (CHILW) store are around 30 years old and the SLC states that a recent visual inspection showed that externally the drums appear to be in an acceptable condition. The CHILW in these drums will in due course assumed to be around 2017) be conditioned into 500 litre stainless steel disposal containers.

3.1.3.2 Future build engineered stores

The Dounreay LTP is based on the availability of a GDF in 2040 in line with other NDA sites. However transfer of waste to such a facility is not envisaged within current Scottish Government policy. The LTP has not yet been amended to reflect this position. All new ILW stores within the LTP have a quoted design life of 100 years. This also assumes that an existing on-site LLW store can be converted into an ILW store and its life extended to 100 years. The SLC has stated that the contingency arrangement for this plan is the construction of a new 100 year design life store. Until further instruction is received from NDA on the implementation of Scottish Government Policy, DSRL maintain a risk that the conditioned ILW cannot be transported off-site to a GDF.

3.1.4 Magnox Reactor Sites

Table 2 – Overview of Magnox reactor sites

Site name	Location	Start of generation	End of generation
Chapelcross	Near Dumfries	1959	2004
Hunterston A	Ayrshire	1964	1989
Trawsfynydd	Gwynedd	1965	1991
Oldbury	South Gloucestershire	1967	2008/09
Wylfa	Anglesey	1971	2010/11
Berkeley	Gloucestershire	1962	1989
Bradwell	Essex	1962	2002
Dungeness A	Kent	1965	2006
Hinkley Point A	Somerset	1965	2000
Sizewell A	Suffolk	1966	2006

In the current Business Plan, NDA has provided KPIs for 2008/9 to a number of Magnox sites. These include:

- Commencement of installation works for ILW retrieval facilities at Hunterston A.
- Processing of seven tonnes of Fuel Element Debris (FED) at Dungeness A.
- De-sludging of ponds at Hinkley Point A.

3.1.4.1 Operational and historical wastes

Historical ILW storage facilities on Magnox sites have some of the highest SED scores in the Magnox fleet. These vault stores typically contain fuel element debris, activated items and sludges. The LTP programme is to retrieve the ILW, treat, package and export it to an engineered interim store pending the availability of a GDF. Stores will be commissioned and made available to support this retrieval programme from as early as 2008 (Trawsfynydd) through to 2019 (Oldbury). It has been recognised that opportunities exist for waste minimisation and that final packaged waste volumes may be lower than the current baseline figure.

Operational ILW and ILW arisings from care and maintenance preparation covers a broad range of materials including metals, e.g. activated and contaminated steels, concrete, fuel element debris (including graphite sleeves) and ion-exchange resins.

At Trawsfynydd good progress is being made in terms of ILW retrievals, conditioning and packaging where the majority of the raw waste is now packaged in a disposable form and ready for transfer to the purpose built ILW interim store. By March 2008, some 60 ILW boxes had been produced out of predicted total 260 and 1719 drums had been produced out of a predicted total of 2448. Hunterston A is also making progress with delivery of their ILW interim store. The latest position is that the store should receive ILW disposable packages from November 2010. Furthermore, in the current NDA Business Plan two KPIs are in place for Hunterston A, which are concerned with ILW treatment and they are¹²:

- Commencement of site installation works for the Solid ILW Retrieval Project.
- Commencement of site installation works for Cartridge Cooling Pond (CCP) ILW sludges and resins.

3.1.4.2 Storage during care and maintenance

A programme of store construction across the Magnox sites has been developed to support the retrieval of historical wastes and the preparation for the care and maintenance phase of reactor decommissioning. All planned Magnox stores have a quoted design life of at least 100 years (see Table 7 in Appendix 4).

Store environmental control parameters have not yet been specified for the later Magnox stores as it is too early in the design stage. However, the SLC expects them to follow the experience of the early stores (e.g. Hunterston controls humidity and chloride levels) and guidance issued by RWMD. Stores are required to follow good practice established for monitoring and inspection regimes.

Within LTPs there are programmes of work to carry out maintenance and asset care. However the cost estimate for these activities depends on the assumption that the GDF will begin receiving waste in 2040. The SLC has contributed to an NDA-led programme of work to review the national ILW disposal schedule including the development of alternative schedules and prioritisation across the estate. This will inform future store emptying schedules in the LTP.

Currently the transfer of waste from Magnox interim waste stores to the GDF is planned to begin after 2040 in a staggered delivery programme. Planning restrictions exist at certain sites which mean they can only store ILW from that particular site or a store emptying timeline is in place. An example of this is Hinkley Point A where the planning consent states 'the radioactive waste storage building hereby permitted, together, with all waste stored therein shall be removed from the site within three years, or such longer period as may be agreed in writing by the County Planning Authority, of a national facility for the long term management of ILW or other alternative means of off-site storage or disposal becoming available'. See Table 7 for further details.

Magnox South is currently investigating the application of alternative treatment techniques for the wastes that will arise during care and maintenance preparations. Technologies such as high temperature treatment and containment in robust containers could significantly reduce waste volumes and therefore the amount of storage space needed.

Recently submitted 2008 LTPs for Magnox sites are currently being reviewed in light of the current NDA Business Plan and prioritisation of available funds towards high hazard facilities. As a consequence of this there will be delays at some sites to the interim store construction and operation programmes set out in Table 7 (in Appendix 4).

It is also noted that during 2008/09 Magnox North updated its guidance document on 'the care and management of ILW packages' to reflect changes in technical understanding and developments in the industry over the last five years since the document was first issued.

The guidance document describes the range of methods which may be used during the lifecycle of an Intermediate Level Waste package to prolong its life as far as is practicable; e.g. through controlling the temperature, moisture and chloride levels. The updated document has benefited from a range of industry input, e.g. comments from the Nuclear Waste Research Forum, which includes representatives from the regulators and other nuclear licensees.

3.1.4.3 Final site clearance wastes

After preparations are complete Magnox sites will enter C&M where typically two reactor buildings and the ILW store will be left for a number of decades. The ILW store will be scheduled for emptying once the GDF becomes available. The exception to this is Wylfa, where a separate ILW store is expected not to be required due to the small number of waste packages to be produced. The plan is to store the packages within the reactor building during the C&M phase. The transfer of waste to the GDF is not envisaged within current Scottish Government policy. The LTPs for sites in Scotland have not yet been amended to reflect this position.

The C&M programme permits radioactive decay of short-lived radioisotopes and in the meantime allows for other higher hazard facilities to be decommissioned and their wastes will be exported be sent to the GDF first. This concept is known as the 'Safestore strategy' and could run for 100 years or more and is still subject to Regulator approval. The Safestore concept is the baseline and will be reviewed in future to allow for a change in strategies and available technologies.

At the end of the C&M programme the typical Magnox site will undergo final site clearance where large scale decommissioning activities will take place. Large volumes of ILW will be produced at this stage with the main components being bulk reactor graphite, concrete and steel. The current strategy for ILW arising from final site clearance activities is for it to be conditioned, packaged and exported to the GDF without the need for interim storage.

NDA is about to embark on a management options development programme, which will investigate alternative approaches to the current bulk reactor graphite waste treatment and disposal route. Magnox could take the lead in delivering better proposals for graphite treatment, recognising the waste management hierarchy and emerging value framework principles.³⁵

3.1.5 Research Sites – Harwell and Winfrith

The Harwell site is located in Oxfordshire and was established in 1946 as Britain's first Atomic Energy Research Establishment. The campus, of which the designated site forms a part, is home to a wide range of research organisations and businesses. The NDA has responsibility for 110 hectares of land - approximately one third of the total area. The creation of Research Sites Restoration Ltd (RSRL) covers the Harwell site in Oxfordshire and the Winfrith site in Dorset (and follows on from the creation of DSRL in April 2008). UKAEA will remain the parent body of both sites until competitions for new owners of the companies are completed.

Winfrith is located near Poole in Dorset and has a total site area of 88 hectares. It was established by the UKAEA in 1958 as an experimental reactor research and development site.

³⁵ http://www.nda.gov.uk/documents/upload/NSG38_Briefing_value_framework.pdf

In the current Business Plan NDA has provided Key Performance Indicators for 2008/09 to :

- recover 132 cans of historical wastes from the tube store at Harwell.
- complete the immobilisation of Steam Generating Heavy Water Reactor (SGHWR) sludges in the Waste Encapsulation Treatment Plant at Winfrith.

3.1.5.1 Historical wastes and existing stores

Harwell has a number of historical stores in operation. Wastes from these will be transferred (after conditioning where necessary) either into the new ILW store once it is available or into an existing facility. This existing vault store is intended to be used for storage until the GDF is available in 2040. This is a relatively modern store (late 1990's); it is currently operating at approximately 19% of its capacity. The SLC has stated that subject to suitable investment to refurbish or replace the crane, this store could potentially be extended by 50 years to achieve a service life of 100 years. This has not been subject to detailed assessment however the SLC states that replacement would be technically difficult. Additionally the store ventilation systems and monitors would also require replacement and the building would require re-cladding at intervals to achieve a 100 year service life.

At Winfrith the Treated Radwaste Store is the only existing long term store and was constructed in the 1990s but not fully commissioned at the time. It has recently been refurbished and commissioned; however its quoted design life is based primarily on the plans at the time of construction rather than on a life limiting feature. The store is a portal frame construction with concrete shield walls. Externally the store would require re-cladding and re-roofing probably twice over 100 years (Table 8 in Appendix 4). In addition, the building cranes, ventilation systems, control systems etc. would all require replacement, possibly several times, to meet another 100 years of operation.

3.1.5.2 Future build engineered stores

New ILW stores are scheduled to be built at Harwell and Winfrith. Each store will be designed to hold disposable packages post conditioning. The SLC has indicated they could be designed and built to achieve a 100 year lifetime. Design lives quoted are based solely on the planning assumption of GDF availability in 2040.

Across both sites, stores have varying levels and types of environmental controls and monitoring and inspection regimes. These reflect both the types of waste stored and the age of the facilities. Environmental control measures are more developed within the modern stores. Some older stores have no means of controlling store environment and the wastes within these stores are scheduled to be conditioned and transferred to modern stores (existing and future build) in the period up to 2020.

3.2 Non-NDA Sites

3.2.1 British Energy

BE owns and operates eight nuclear power stations in the UK – seven AGR stations and one PWR. Details of these stations are given in Table 3.

Table 3 - British Energy reactor sites

Site Name	Reactor type	Location	Start of generation	End of generation
Dungeness B	AGR	Kent	1983	2018
Hartlepool	AGR	Teesside	1983	2014
Heysham 1	AGR	Lancashire	1983	2014
Heysham 2	AGR	Lancashire	1988	2023

Site Name	Reactor type	Location	Start of generation	End of generation
Hinkley Point B	AGR	Somerset	1976	2016
Hunterston B	AGR	Ayrshire	1976	2016
Torness	AGR	East Lothian	1988	2023
Sizewell B	PWR	Suffolk	1995	2035

Currently each site has both tanks, for storage of wet wastes such as ion exchange resins and vault storage facilities dry ILW wastes. Ion exchange resins will be conditioned into solid waste forms before transfer into an interim store. Hunterston B and Hinkley Point B also accumulate ILW desiccant³⁶ in vaults. Other AGR sites store their ILW desiccant within designated drummed storage facilities. It should be noted that the current waste management route for ILW desiccant is treatment/decontamination to LLW to facilitate disposal at the LLWR. Hence, the desiccant operational arisings are not included within the ILW waste quantities which will be routed to the on-site ILW stores (NB: Sizewell B PWR does not have ILW desiccant waste arisings).

BE is pursuing an Early Safe Store (ESS) strategy for their AGR stations which consist of the following stages and timings:

- Decommissioning Activity 0 - Pre-Closure Planning
- Decommissioning Activity 1 - Defuelling
- Decommissioning Activity 2 - Decommissioning Engineering Preparatory Work
- Decommissioning Activity 3 - Management of Potentially Mobile Operational Wastes
- Decommissioning Activity 4 - Plant Decommissioning
- Decommissioning Activity 5 - Safestore Construction
- Decommissioning Activity 6 - Site Surveillance Care & Maintenance
- Decommissioning Activity 7 - Preparation for Reactor Dismantling
- Decommissioning Activity 8 - Vault Waste Management
- Decommissioning Activity 9 - Reactor Dismantling
- Decommissioning Activity 10 - Site Clearance

Activity 0 - covers the three year period prior to station end of generation.

Activities 1-5 - covers an approximate 10 year initial decommissioning period immediately after end of generation.

Activity 6 - C&M lasts for approximately 75 years.

Activities 7-10 - covers an approximate 10 year period, starting 85 years after end of generation.

The plan for Sizewell B decommissioning is Early Site Clearance (ESC), with all decommissioning activities completed within a period of approximately 20 years after end of generation. The engineering activities are similar to those shown for the AGR stations, but with no Safestore being constructed or C&M period taking place.

An ILW store will be constructed at each AGR site to support activities 2-5. All of the proposed AGR station stores have a quoted design life of 50 years, but their design renders them relatively amenable to life extensions. An additional life of 50 years is believed to be achievable with suitable maintenance (such as re-cladding). However, this has not been subject to detailed consideration. The Sizewell B store has a 50 year design life and has a configuration like most other modern ILW stores in the UK in that it utilises overhead cranes for waste handling. Given the design, construction, mode of operation and maintenance regime of the store there is anticipated to be good prospect of store operational lifetime extension. The Sizewell B ILW store currently only stores small quantities of operational waste. Bulk filling is required to commence *circa* 2010.

³⁶ Desiccant is used to dry reactor coolant gas streams

The BE (AGR stations) ILW management/ interim storage model differs considerably from that of the Magnox reactors due to the limited volume of ILW which requires interim storage on each site (predominantly operational wet wastes - British Energy sites do not hold large volumes of fuel element debris). Operational and C&M preparation waste from the BE reactors will be conditioned into 500 litre drums and placed in a concrete over-pack for storage. Packages are handled *via* a straddle carrier rather than an overhead crane so removing one of the factors that limits the life of typical ILW stores. Additionally the store structure does not need to meet seismic standards because of the additional layer of containment provided by the over-pack.

Whilst store design is still at an early stage some information is available on the proposed environmental controls and monitoring and inspection regimes. The stores will have temperature and humidity monitors with ventilation and extract systems. Regular visual inspections of the store fabric and over-packs are anticipated. Quarterly inspection of interior of over-packs using endoscopes inserted through ports in over-pack lids are envisaged. The exact scope of inspections will be agreed with the Regulators at an appropriate time.

At this stage none of the BE AGR wastes have been assessed for disposability through the LoC process. This is not unreasonable given that the AGR stations have not had to develop conditioning processes for their operational wastes. As the stations near the end of their operating life and start to make preparations for decommissioning activities 1 to 3, this situation can be expected to change. It should also be noted that these AGR operational wastes are similar to the equivalent Magnox ILW arisings for which LoCs have been issued – and appropriate conditioning/treatment has been carried out. Opportunities may exist for volume reduction utilising high temperature processes for wet wastes.

Final demolition and site clearance decommissioning wastes from the AGR stations will be packaged into four metre boxes and consigned directly to the GDF.

All of the proposed AGR station stores have a quoted design life of 50 years, but their design renders them relatively amenable to life extensions. An additional life of 50 years is believed to be achievable with suitable maintenance (such as re-cladding). However, this has not been subject to detailed consideration. The Sizewell B store appears to be the least tolerant to lifetime extensions because of its age and more complicated mechanical equipment. Some degree of life extension is believed to be possible although this has not yet been subject to detailed engineering assessment. Differing store service lives could be managed to some degree by prioritising the disposal of Sizewell B waste over the other BE sites.

3.2.2 Ministry of Defence (MoD)

The MoD is currently planning to store waste at Aldermaston up until the 2040 GDF planning date. This store is approximately 10 years old and is quoted as having a 100 year design life based upon refurbishment at 25 year intervals. Despite this stated design life there is uncertainty over the level of seismic qualification of the foundations of this store. There is currently no forced ventilation within this facility as it is not deemed necessary by the operator.

Some sea disposal drums are also in storage at Aldermaston and the plan for this waste is to assay and rework the wastes, allowing segregation of LLW and supercompaction of ILW.

The store inventory contains drummed, unconditioned PCM, which is scheduled for conditioning into an agreed disposable product from around 2013.

MoD will continue to generate ILW from operations, research and decommissioning at Aldermaston. The bulk of this waste will arise from a 30-40 year decommissioning programme.

In addition to the waste at Aldermaston additional waste will be generated from the decommissioning of nuclear submarines. This waste arises from the dismantling of the Reactor Compartment and is largely activated steel. No interim stores have yet been planned to be constructed for this material.

Small quantities of operational ILW exist at dockyards. A proportion of this waste is decayed to LLW and can potentially be disposed of at the LLWR. Remaining wastes are expected to be transferred to a yet to be determined ILW store together with the ILW arising from submarine decommissioning.

NDA is currently working with MoD to develop a forward strategy on decommissioning and radioactive waste management.

3.2.3 GE Healthcare

GE Healthcare generates ILW from decommissioning of legacy industrial plant and the manufacture of healthcare products for imaging, treatment and research. They operate an ILW store at each of their Amersham and Cardiff sites.

The store at the Amersham site is not ventilated and as such does not accept any gaseous emitting waste. The bulk of the waste is from decommissioning operations plus short half life material from current productions and is handled remotely. The store was built in 1997 and has no defined end date – future commercial contracts determine the demand for the store.

The store at the Cardiff facility was built in 1998 and, like the Amersham store, the lifetime demand will be determined by future commercial contracts. Ventilation was retrofitted into the store in 2002 and it holds solid and liquid waste.

GE Healthcare is implementing a number of waste minimisation initiatives including investigating alternative decay storage regimes and tritium recycling.

3.3 The approach to the interim storage of packaged wastes

3.3.1 Existing engineered interim stores for packaged wastes

For existing interim stores there are three main types which can be differentiated with respect to their operational design lives:

- Stores with an original design life of at least 100 years.
- Stores with an original design life of less than 100 years but capable of being extended.
- Stores with an original design life of less than 100 years and having no practicable life extension capability.

Most existing stores in the UK have a typical original design life of 50 years. During the construction of these stores the projected GDF availability date was 2012 and a 50 year design life was sufficient to allow for some changes to this date. The majority of existing interim stores are at Sellafield and the SLC has reported that there is potential to extend the operational lifetime to at least 100 years except in the case of two stores. As a consequence the current LTP covers the requirement for two new replacement stores. Some of the existing stores contain unconditioned ILW that will require additional processing before export to the GDF.

In summary, the approach for existing engineered interim stores is as follows:

- For stores with an existing original design life of 100 years or more, the site operator will need to protect the asset to ensure its longevity and ensure contingency plans are robust up to 2106 as a minimum with a clear understanding of any potential cliff-edges.
- For stores with an existing original design life of less than 100 years:
 - As a minimum the site operator must ensure that the predicted service life of the store is compliant with the declared baseline operational period, which takes into consideration required asset care programmes.
 - As a contingency, the site operator should assess if the operational life of the existing facility could be extended to 100 years or more.
 - If it is not possible to extend the operational lifetime, then the site operator should as a contingency, plan to relocate the waste to another store or plan for a new store with a design life of 100 years or more. The site operator should also consider the current planned export dates to the GDF in consultation with NDA.
 - The site operators should ensure appropriate level of scope and cost coverage within their LTPs address any risks in their storage plans, for example any increased store maintenance refurbishment costs associated with extending store lifetimes.
 - Where operational design lifetimes could be extended, the site operator will need to understand when key decisions will need to be made and factor these into their LTPs whilst monitoring progress with the GDF project.

3.3.2 Future interim stores

For future interim stores that are yet to be built there are two possible scenarios for operational design lives:

- Stores with a design life of 100 years or more.
- Stores with a design life of less than 100 years but capable of being extended.

For all future stores considered within this Review there were none where the operational design life was not aligned to the operational storage period declared by the site operator. Some site operators have declared store design lives of less than 100 years to match their current baseline position and include little if any contingency against the possibility of GDF delay. In the case of British Energy ILW interim stores, the site operator has stated that due to more straight-forward storage demands and simplicity of design, the store is flexible, and the operational period could be extended to 100 years.

In summary the proposed position for future interim stores is as follows:

- All new interim stores should have a design life of 100 years or more.
- The NDA will engage with Regulators and operators to investigate the need for a guidance note to site operators on the storage of radioactive wastes.
- An original operational design life of less than 100 years may be acceptable if site operators can demonstrate that in-service improvements and asset care programmes for the store will extend the operational life to 100 years or more. Anticipated additional costs must be shown as contingency planning, or:
- An original operational design life of less than 100 years may be acceptable if the design life of the store will cover a period of interim storage up to 2106, as a minimum.

3.3.3 Store Lives and Decision Making

This Review has highlighted the importance of understanding when key decisions on storage operations must take place. These decision points are affected by both the storage facility and any changes to the planned availability of the GDF. However, it should be noted that throughout the operational life of a HAW storage facility it will be subject to safety case review during which expected improvements will be made.

Figure 11 is for illustrative purposes only and considers the key decision dates for an engineered store at Sellafield where the original design life covers a period of up to 2040. Allowing a conservative assumption of a ten year lead time from making a decision to rebuild a store to having the new store fully operational, this gives a decision date of 2030. As detailed in Appendix 5 the SLC is addressing a potential life extension for this facility should GDF availability take longer than currently assumed. This example demonstrated one of the earliest decision dates for an existing store.

Figure 12 is also for illustrative purposes and shows the key decision dates for a future planned engineered store at a Magnox site. This store is not due to start operations until 2012 and the already carries a 100 year design life. This example demonstrates the greatest level of flexibility in storage planning.

Figure 11 – Existing Sellafield store key decision points

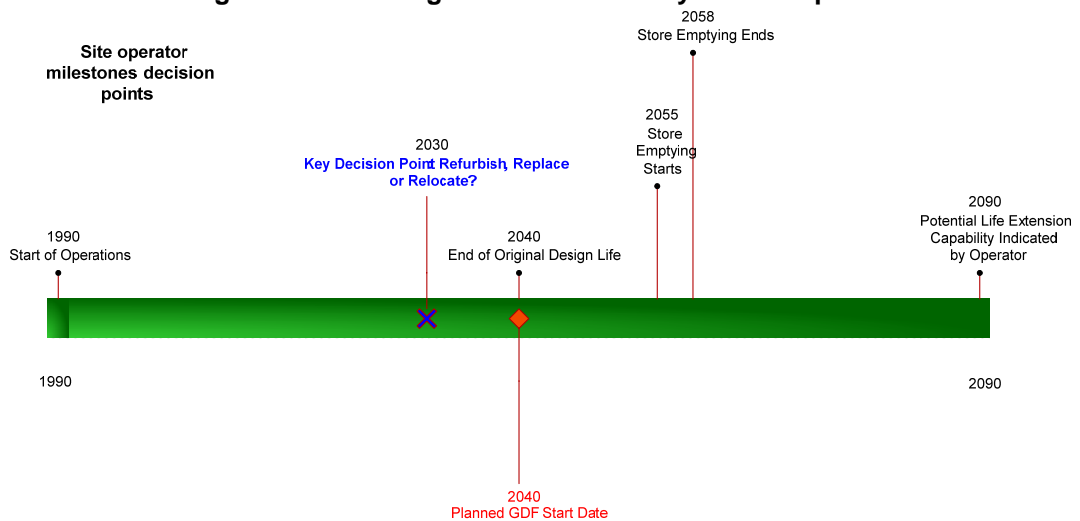
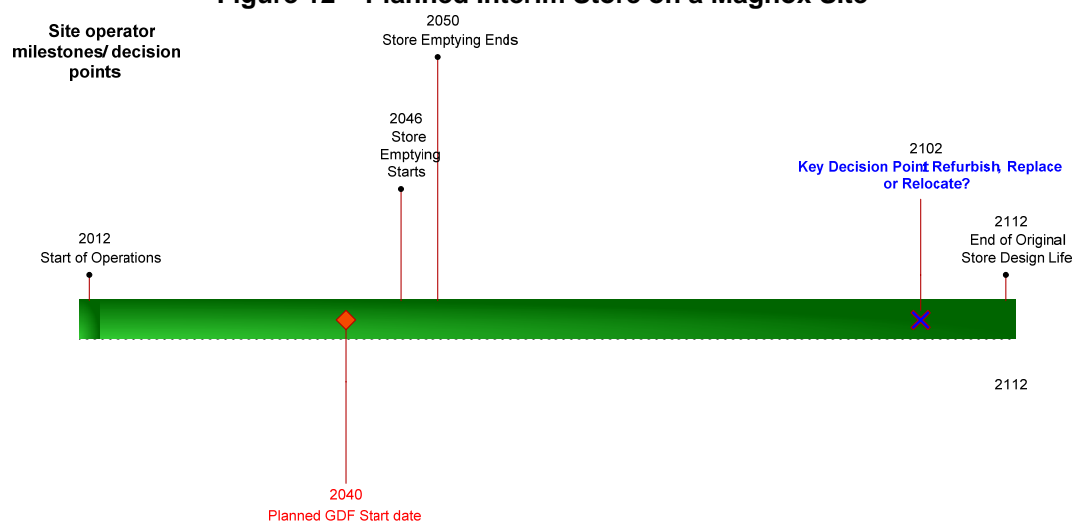


Figure 12 – Planned Interim Store on a Magnox Site



Chapter 4: Key Findings and Review Conclusions

This chapter highlights the key findings and conclusions of the Review, which will help to support the development of waste packaging and interim storage programmes for HAW.

4.1 Key findings

4.1.1 Historical waste retrieval and conditioning

Across the NDA portfolio the historical waste facilities at Sellafield and Dounreay are the most hazardous and are the top decommissioning priority. This is reflected in the programme of work set out following NDA's 2008-2011 Business Plan.¹² The conditioning of historical wastes followed by interim storage within a modern facility provides a dramatic reduction in both risk and hazard.

The majority of the current inventory of ILW has not yet been conditioned for disposal or long-term storage and is stored in ponds, silos, vaults or remain *in-situ* pending facility decommissioning. According to the 2007 UK National Waste Inventory, by April 2007 21,000 m³ of ILW was conditioned out of possible 92,500 m³. The total ILW conditioned volume inventory is expected to be 236,000 m³.

Retrieving and conditioning wastes from historical facilities presents significant challenges due to the age of the buildings, the chemical behaviour of the wastes, physical and radiological inventory and the relatively large volumes to be considered. In the case of certain waste streams at Sellafield, disposable packages may need to be achieved in a staged approach, where the immediate priority is retrievals into better storage conditions.

4.1.2 Historical conditioned wastes requiring further treatment

Through historical practices some conditioned wastes have been produced that do not meet requirements for geological disposal and will be repackaged for continued safe interim storage and eventual disposal. Waste such as plutonium contaminated material are currently packaged in 200 litre drums and crates for storage or in larger drums that were for sea dumping prior to the 1983 moratorium on sea disposal.

The current strategy aim is that by 2040 all historical wastes on NDA sites will be in a disposable form, which meets the requirements of the LoC process and any operational waste requiring further attention, will have an agreed management route in place.

4.1.3 Interim storage of wastes

Within existing engineered interim stores at Sellafield there are concerns about the future integrity of packages that contain chemically reactive metals. This is the subject of an ongoing review by the SLC under the close scrutiny of the Regulators.

This NDA Review has highlighted inconsistency of approach to waste storage across the UK. This has resulted from changing standards over time, different organisations adopting different approaches and previous assumptions about relatively early GDF availability (2012).

With regard to packaged wastes in storage it has been noted that there are inconsistencies and in some cases shortfalls in the environmental controls and monitoring in stores. This is evident in both existing stores and in plans for new stores. Whilst passive systems may be the preferred option this may not always be achievable.

Some unconditioned operational wastes are currently being held in engineered interim stores and the current strategy is to retrieve and condition into a disposable form prior to export to the GDF. These wastes tend to be relatively stable material forms such as graphite and activated stainless steel components.

Throughout the operational life of a higher activity waste storage facility it will be subject to periodic safety case reviews and as a result of which, any necessary improvements are made.

A significant quantity of waste, largely arising from the final site clearance stage of Magnox and AGR reactor decommissioning and post 2040 decommissioning at Sellafield, will be consigned directly to the GDF without any interim storage period. The waste consists of the material which is held up within the Safestore structure undergoing the C&M phase of reactor decommissioning and the decommissioning of facilities at Sellafield.

4.1.4 Security

Security measures in the civil nuclear industry are applied in a graduated manner in accordance with the severity of the threat and the level of consequence of a successful attack in a manner that provides defence in depth. For example, PCM and fuel contaminated wastes require more substantial security measures than contaminated material such as steel from plant decommissioning.

Early and continued engagement with the OCNS on security matters during the design and construction stages of future ILW stores will enable SLCs to more efficiently incorporate existing and emerging security measures to be built in thereby avoiding the need for expensive retro-fitting at a later date.

The security situation is constantly under review both in terms of the threat and emerging security improvements and changes to either may result in amendments to SSPs and could incur considerable cost.

In his last Annual Report the Director, Civil Nuclear Security stated that security in the nuclear industry was effective.

4.1.5 Storage Optimisation

In 2006 and 2007 NDA, supported by Magnox South and UKAEA, carried out a review of opportunities to optimise the interim storage of packaged ILW. The large majority of ILW arises, and will be stored at Sellafield, as described in the site LTP. Many other sites already have ILW stores in place, or are planning on-site stores. It was therefore concluded that there is limited scope for storage optimisation by transfer of waste from site to site. The option of consolidating ILW at Sellafield has been proposed but it is not widely supported because of the local planning presumption³⁷ against waste import. The baseline storage arrangements at sites around UK are adequate to hold ILW until the geological disposal route becomes available.

³⁷ <http://www.cumbria.gov.uk/eLibrary/Content/Internet/538/755/2146/389021340.pdf>, p4.

The Review concluded that there may be scope for consolidation of more than one site's waste at some of the NDA sites in the south of England. NDA has no intention of pursuing a radically altered waste storage regime such as a single very large low maintenance UK facility.

It is recognised that whilst this study was being prepared the Scottish Government did not endorse the 2007 Managing Radioactive Waste Safely White Paper, as it did not support a policy of deep geological disposal for HAW. The NDA is working with the Scottish Government as it develops its policy and the options and issues identified in this report will be considered in that process.

4.1.6 Planning consents

Across the existing and planned stores two types of planning constraint exist – restrictions on the origin of the waste (site specific) and store emptying deadlines. Many of these constraints have arisen out of a climate of uncertainty over the availability of a disposal route.

4.1.7 Other considerations

Knowledge management and record management across inter-generational timescales are essential. Without this information, meeting the future regulatory requirements for transport and disposal would be severely compromised. The Radioactive Waste Policy Group³⁸ has developed guidance on the maintenance of long-term records by nuclear site operators.

ILW reactor decommissioning wastes were specifically highlighted in 2006 by CoRWM, Recommendation 8, which stated; 'In determining what reactor decommissioning wastes should be consigned for geological disposal due regard should be paid to considering other available and publicly acceptable management options, including those that may arise from the low level waste review'. The NDA is therefore considering the possibility of alternative management options for reactor decommissioning wastes, which will have a significant input into the developing strategy for HAW.

This review does not cover Research and Development activities and therefore does not address CoRWM Recommendation 4.³⁹ However, it is noted here that the NDA is in the process of developing a HAW generic R&D programme that will consider the needs of the industry and strategic waste management opportunities that may include the following; alternative waste processing, alternative containers, remote monitoring and inspection techniques, long-term corrosion studies and alternative waste encapsulants. Such activities may be led by the SLCs, as well as through the NDA's Direct Research Portfolio and will help to support the NDA's HAW Strategy programme.

4.2 Review conclusions

The conclusions are broken down into the sub-headings that match the structure of CoRWM Recommendation 2 and Government's response. This section also considers broader issues that relate to strategy development and UK waste management initiatives.

4.2.1 Reviewing and ensuring security, particularly against terrorist attacks

Liquid and unpackaged historical wastes in old facilities are naturally a relatively high level security concern, but they are located at sites with high levels of security protection. Rigorous independent security regulation systems are in place across all nuclear licensed sites regardless of owner or operator.

³⁸ Radioactive Waste Policy Group is a cross Government Department group

³⁹ CoRWM 4 Recommendation - 'There should be a commitment to an intensified programme of research and development into the long-term safety of geological disposal aimed at reducing uncertainties at generic and site-specific levels, as well as into improved means of storing wastes in the longer term'.

Modern engineered waste stores have a number of in-built mechanisms designed to separate waste packages from the environment and human intrusion. Because of these features, packaged wastes in well engineered stores are a relatively low security risk.

The security of nuclear waste material transported outside of licensed sites is covered in a similar manner using Transport Security Plans (TSPs) and Transport Security Statements (TSSs). Nuclear material should ideally spend the least possible time in transit and be subject to the least number of inter-modal changes.

Site Security Plans (SSPs) are protectively marked and they detail the standards, procedures and specific arrangements that must be kept in place to ensure the security of the nuclear premises, nuclear material in whatever category, form or quantity and sensitive nuclear information against the malicious capabilities posed by the Nuclear Industries Malicious Capabilities Planning Assumptions. This document allows a judgement to be made with regard to the malicious capabilities that could be deployed against a licensed site or transporters and against which security measures should provide protection. It draws on intelligence provided by the national intelligence agencies particularly the Joint Terrorist Analysis Centre of which OCNS is a member.

4.2.2 Ensuring the longevity of the stores themselves

Management of stored waste packages is not solely focussed on the store building structure. A multi barrier approach must be employed with the store performing the function of the final barrier which also protects the package from the environment. Safety and environmental impact of the waste form should be the primary concerns.

The latest and future packaged waste stores are designed to match a reasonable timeline to suit potential GDF availability dates. They will all require appropriate maintenance and various levels of in-service refurbishment, but could operate beyond 2100, and in principle meet CoRWM's '100 years or more' objective.

A number of existing packaged waste stores have shorter notional design lives and are likely to require relatively more extensive in-service refurbishment to achieve the 100 years or more objective. It is possible that in some cases it would be better to transfer wastes into another store either on grounds of radioactive dose minimisation or cost. Further work at site level is needed to assess what would need to be done to extend the lives of individual stores and investigate whether replacement stores might be needed.

Whilst the '100 years or more' storage objective is attainable, if it were to be concluded in coming decades that geological disposal is not wanted or not feasible until well after year 2100, then there might be a case for switching to a new long-term storage regime. Meanwhile the present approach meets the requirements for secure waste storage until GDF filling takes place post-2040. It is not considered that there would be any justification for moving to a more conservative regime entailing new stores capable of operating over periods well in excess of 100 years at the moment.

4.2.3 Prompt immobilisation of waste leading to passively safe waste forms

Unpackaged historical wastes in storage carry the greatest level of risk across the NDA estate because of their reliance on active systems to maintain their safety and environmental protection status. Some of the buildings housing these wastes were constructed in the 1940's and 1950's and would not meet modern standards of design and construction. NDA's priority is to ensure historical wastes are removed from these ageing facilities and immobilised at the earliest safe opportunity. Packaged wastes (holding a LoC) in modern storage are of relatively much less concern.

4.2.4 Minimising the need for repackaging of the wastes

The LoC assessment process operated by NDA RWMD is designed to give confidence to SLCs and stakeholders that their proposals for conditioning and packaging of waste will lead to waste packages that are consistent with the needs for transport and disposal. By working with RWMD during the design phase, the SLC gets increased confidence in the 'disposability' of the proposed waste packages therefore minimising the risk of future repackaging. This process is consistent with regulatory guidance⁴⁰ and NDA RWMD advice is expected to form one of the inputs to the SLC's Radioactive Waste Management Case.⁴¹

All wastes being conditioned for long-term storage and disposal should be supported by safety cases underpinned by an understanding of how the conditioned waste and waste containers will behave over time. Periodic monitoring should be undertaken to provide confidence that the packages are evolving as predicted by the safety cases. Experience at Sellafield has shown the importance of this, as some packages have not been behaving as expected. This has been detected by the periodic monitoring and therefore Sellafield has the opportunity to put in place the necessary work to improve understanding of the processes and to assess whether any remedial work is required. Such remedial work could entail over-packing or 're-working' during the storage phase or at the time of eventual consignment to the GDF.

Some LoCs have been issued with caveats which must be addressed by waste producers in a timely manner to minimise uncertainty. Regulators are encouraging NDA RWMD and sites to seek early close-out of such issues. Periodic LoC reviews have been introduced and will provide a mechanism for keeping LoCs and disposability assessments up to date and in line with evolving safety cases. They also provide an opportunity to review the ongoing relevance of these caveats, but national monitoring of their status should be maintained.

Plans for the interim storage of unencapsulated wastes should always consider the full waste management lifecycle including any further conditioning steps, transport and disposal. These wastes should also apply the LoC process where more than one conditioning step might be deemed appropriate by the waste producer and the Regulators.

4.2.5 The implications for transport of wastes

Transport is a key consideration in the waste management lifecycle including any potential movements of waste between sites prior to disposal, *e.g.* storage optimisation. It should be emphasised that compliance with transport regulations/requirements will be required to be demonstrated in addition to compliance with disposal acceptance criteria, as waste packages will be transported within the public domain. It is also recognised that public and stakeholder engagement is an essential activity and has to be an integral part of the long-term waste management programme.

4.2.6 Implications for future storage planning

As the schedule of waste emplacement within the GDF develops (including understanding commissioning and ramp-up timescales) guidance will be provided by NDA to SLC's in order to ensure any amendments to the site LTPs are made and adequately underpinned. NDA will be working with sites to develop an optimum store emptying schedule. A preliminary schedule is already in place (see Figure 9).

The latest engineered interim stores have quoted design lives of 100 years (50 years plus 50 years extendibility) or even 150 years. Subject to ongoing safety case considerations, these are sufficient to permit storage until wastes are consigned to disposal according to baseline plans that show GDF filling from 2040 onwards providing adequate maintenance is carried out to achieve these durations.

⁴⁰ <http://www.hse.gov.uk/nuclear/wastemanage1.pdf>

⁴¹ Regulatory requirement set out in HSE, EA and SEPA guidance referenced above

Some future stores are planned to be constructed to operate only for the 20 to 50 years before they are scheduled to be emptied. Noting the uncertainty regarding the GDF availability date it will be necessary to set out contingency arrangements for extended operation if required. There are no critical decision points in the short term.

Some of the existing stores were built on the assumption that waste could be consigned to disposal around 2012. Additional work might be required to ensure that the stores can be extended to match the current 2040/2075 baseline timeframe or that replacement stores are allowed for if life extension cannot be achieved economically. Typical activities for life extensions include cladding replacements, ventilation upgrades and crane refurbishment.

The NDA's Waste Storage Optimisation study is relevant to the industry's future waste storage planning. The main points can be summarised as:

- NDA should continue to encourage the development and realisation of waste minimisation, alternative waste packaging and decay storage opportunities to help reduce the overall NDA liability, *i.e.* reduce the overall number of ILW packages (and potentially ILW interim stores), and thus increase storage flexibility.
- The main focus of investigating storage consolidation opportunities for NDA ILW should be southern Magnox and UKAEA sites.
- Stakeholder engagement is a key consideration and should be applied to any proposals to transfer wastes between sites.
- Any storage optimisation process solution will involve the transport of waste from one location to another and transport must be seen as a key enabler.
- There may be opportunities to extend the study to include other waste owners for example, it may be reasonable to consider a single ILW store for co-generation BE/NDA sites.

Chapter 5: Way Forward and Further Work

This chapter describes the proposed approach and task areas to be considered as part of a forward programme, which will be co-ordinated by the NDA.

5.1 Way forward

As this Review mainly focussed on Government's response to CoRWM Recommendation 2 and the NDA strategy commitment on ILW Storage Optimisation, there are areas of further work which could focus on specific issues raised. A series of more detailed reviews should also be considered as part of a forward programme and co-ordinated *via* the NDA's HAW Strategy team. The key principles going forward are:

- An integrated lifecycle approach to HAW management that takes into consideration regulation, Government Policy and evolving technologies
- Effective stakeholder engagement is a key component for the success of the way forward

5.2 Further work

NDA with input and support from its stakeholders has compiled a list of potential topics as part of the process to create its future work programme. The key areas identified for future work are:

- Waste characterisation
- Transport arrangements
- Integration and standard approaches
- Waste packaging
- Interim storage of waste
- Storage optimisation
- Common issues

5.2.1 Waste Characterisation

Appropriate waste characterisation and understanding waste behaviour is essential in helping the industry to address important issues, *e.g.* long-term package performance and to tackle opportunities including alternative treatment and packaging solutions, decay storage, sorting and segregation opportunities, novel decontamination techniques. More relevant information is needed to effectively identify and prioritise the R&D that is currently required to address existing issues related to the management of HAW. This is considered an important component of the way forward because of the overall dependence of the interim storage programme on understanding the waste characteristics.

5.2.2 Transport arrangements

It is recognised that whatever future solutions are developed for interim storage, NDA and other relevant bodies cannot leave transportation to sites. Establishing effective and efficient ways to transport wastes from interim stores will involve long lead times. The current transport regulations are continually being reviewed by international experts (IAEA) to ensure they are relevant and applicable to the radioactive material transport regimes in operation now, and expected to be in place in the foreseeable future.

It is not expected that transport of HAW will result in any need to change the regulations since the philosophy of the IAEA regulations is that maintenance of safety must be inherent in the design of the package, and consequently the rigorousness of the design can be tuned to address the regulatory requirements.⁴² However, due to the amount of work needed to optimise the designs and identify the most efficient and safe transport plans NDA and relevant organisations need to now lay out the way forward and begin developing the future capability to transport HAW. For example, common approach to waste transport container design, minimising environmental effects of noise and pollution and co-ordination of container procurement activities.

5.2.3 Integration and Standard Approaches

There is recognition by all stakeholders, that an integrated waste management storage approach should be considered. Although only 'fit-for-purpose' solutions should be pursued, there is a sense that across the industry there needs to be more shared practices or common approaches to problems being used. The NDA's Waste & Nuclear Materials team will continue to drive best practice initiatives by using existing forums, e.g. the Nuclear Waste Research Forum, and issue specific workshops.

5.2.4 Waste packaging

These ideas focus on the need for guidance from the NDA, information sharing, and support for research and development to improve the waste packages currently available:

- Create a clear approach to dealing with unconditioned waste in interim storage.
- Develop a "toolkit" of demonstrated solutions, which could involve early R&D.
- Pursue and encourage innovations with SLC's sharing what they learn and the initiatives they undertake.
- Assess waste package optimisation within the constraints of regulatory and disposal requirements and develop alternative ways forward
- Review LoCs for existing waste packaging including any unresolved issues
- Establish an integrated industry-wide R&D programme for HAW management

5.2.5 Interim Storage of Waste

The way forward for interim storage highlights a need to understand and communicate the current condition of the inventory and identify areas of urgency and develop targets and timelines:

- Understanding the management arrangements for out of specification waste packages.
- Detailed review of historical waste management arrangements and forward programmes.
- Ensure continued review and design of the package and store to deliver a robust interim storage solution.

⁴² IAEA Safety Standards Series No. TS-R-1. Regulations for the Safe Transport of Radioactive Material, 2005 Edition.

- Define the time critical issues that need to be highlighted, prioritise interim storage planning with targets and decisions along a timeline.
- Establish environmental, monitoring and inspection standards across the sites.

5.2.6 Storage Optimisation

Storage optimisation of packaged wastes in interim storage needs to focus on the need for information on how opportunities will be identified, evaluated, and implemented:

- Re-examine the advantages and disadvantages of store *versus* container duties
- Identify the main storage optimisation opportunities from a UK-wide, not just an NDA, perspective and understand the practicalities of the options available
- Review the planning conditions to highlight the existing constraints to optimisation

5.2.7 Common issues

The way forward needs to consider adding definition to the interim storage programme and the development of approaches to the challenges that integrate the various parts for cost effectiveness and efficiency:

- Identify the uncertainties associated with the interim storage of HAW and disposal in the GDF
- Optimise planning through recognising the differences between the risks and challenges at Sellafield as opposed to the Magnox sites
- Develop a network/responsibility diagram that clarifies the rules and responsibilities across UK industry, NDA, regulators, etc
- Consider the possibility of using the GDF location for consolidated storage.
- Communicate clearly to stakeholders the roles and responsibilities across Government, industry, regulators, etc.

5.3 Next steps

As a result of the Review, there are a number of immediate next steps:

- The NDA will share ideas with relevant parties who have direct responsibility for areas of work outside of the NDA's accountability for them to progress directly.
- Where NDA does have the relevant accountability, it will consider the areas of work identified as part of the process of defining its future plans.
- NDA will ensure that its forward programme continues to support its Strategy Management System and in particular the development of the HAW Topic Strategy.
- The NDA will continue to work with the Scottish Government, as it develops its detailed statement of policy and the options and issues identified in this report will be considered in that process.

NDA will ensure that its forward programme on interim storage continues to support the Strategy Management System and the development of the HAW Topic Strategy which will ultimately contribute to the overall NDA strategy. The potential list of topics identified will be assessed and the approach to the interim storage of HAW should be reviewed on a regular basis with clear links to the development of Government policies.

Appendices

Appendix 1- Waste and Hazard Definitions for the NDA Hazard Baseline Project

Please note that these definitions are extracted from the NDA's Hazard Baseline specification.⁴³

The definition of *Hazard* will be:

The threat posed by the waste as measured using the Safety and Environmental Detriment scoring system as defined as '*the potential for harm arising from an intrinsic property or disposition of something to cause detriment*'.

The definition of *potentially mobile* will be:

Any material that has a form factor of gas, liquid, watery sludge and floc, other sludge, powder or loose contamination as detailed in EGR009, The Radiological Hazard Potential, A Progress Measure For Nuclear Clean Up.

The definition of raw waste volume is:

- For sludges and liquids the volume of the waste in its present form under its current conditions of storage.
- For solid wastes such as steels and concrete this is the volume of waste calculated from the mass of the material that is being removed or where this data is not readily available the 'Arisings' volume as used for the national inventory should be used.
- In the case of mixed wastes in silos or similar it should be the volume occupied by the waste within the silo, e.g. swarf in a swarf silo.

If other means of calculating the raw waste volumes is to be used these must be agreed with the NDA Hazard Baseline Project Manager.

The definition of passively safe is:

- A waste form in which the waste is chemically and physically stable and is stored in a manner that minimises the need for safety mechanisms, maintenance, monitoring and human intervention, and that facilitates retrieval for final disposal (Ref Nirex Report N/104 Volume 1, and HSE T/AST/024). Or
- A waste form that meets the conditions for acceptance of its intended disposal facility. Or
- A waste form that has been given specific concessions by the relevant disposal authority in order to facilitate the accelerated clean up of high priority facilities.

⁴³ http://www.nda.gov.uk/documents/upload/EGG_06_Hazard_Baseline_Specification_rev_1.pdf

The definition of 'In Situ' is:

- The waste as it is currently located in its raw form within its plant of origin. Or
- Wastes that have previously been packaged but the packages have deteriorated such that they now require significant rework.

The definition of 'In Process' is:

- The waste which has been recovered or removed from its plant of origin but has not yet been converted to its final form for long term storage/disposal e.g. sludge that has been removed from a pond and stored in a buffer tank prior to treatment. Or
- Waste that has previously been recovered and packaged for disposal but the waste does not fully meet the criteria for long term storage or disposal.

The definition of 'Conditioned' is:

- The waste which has been recovered or removed from its plant of origin and has been processed such that it meets the passively safe criteria and has been placed in a store that meets the requirements for long term storage of the completed package prior to disposal.

The definition of 'disposed' is:

- The waste which has been recovered or removed from its plant of origin packaged and emplaced in a licensed repository or disposal facility.

Appendix 2 - Safety requirements for interim storage

All nuclear site operators are required to hold and abide by a nuclear site licence issued by the Nuclear Installations Inspectorate.⁴⁴ Each licence has attached to it a number of specific conditions relating to all aspects of operating a licensed site. Licence Conditions 28 and 15 are particularly relevant to interim storage of radioactive waste although other conditions are also relevant. Licence Condition 15 refers to 'Periodic Review', which states '*the licensee shall make and implement adequate arrangements for the periodic and systematic review and reassessment of safety cases*'. This Condition ensures licensees regularly review their safety cases for installations against modern standards and where practicable implement improvements to demonstrate safe operations for a defined time period (usually 10 years). In support of this requirement NDA RWMD has initiated a parallel process to review and update extant LoCs, a process that is effectively a periodic review of LoC arrangements.

Licence Condition 28 is entitled 'Examination, Inspection, Maintenance and Testing' where the purpose of the Condition is to ensure '*that all plant that may affect safety is scheduled to receive regular and systematic examination, inspection maintenance and testing, by and under the control of suitably qualified personnel and that records of maintenance activities are kept*'.

It should be recognised that throughout the operational life of a higher activity waste storage facility it will be subject to safety case review where expected improvements will be made. For example, site LTPs should include provision for regular maintenance including major refurbishment programmes such as store re-cladding if planned operational lifetimes are significant. A store like any other nuclear facility must comply with the site licence conditions and will be managed accordingly until the facility is safely decommissioned.

It is an NDA expectation that modern lifetime management practices and an Ageing Management Programme (AMP) (such as that described in IAEA Safety Reports Series No. 15⁴⁵) will be adopted and maintained. Systems, Structures and Components (SSCs) that may affect safety should be included in a systematic AMP such as that shown in Figure 13. Whilst this IAEA report is aimed at reactors the fundamental principles are transferable.

The transfer of information at various stages in the life cycle of a facility is critical to the quality of information available for the lifetime management of the facility and, ultimately, at decommissioning (Figure 14). The collection of data can be problematic if different parties have been involved at each stage and the required information has not been transferred or has been lost. Considerable effort and cost may have to be expended in order to recreate the required supporting information in such circumstances. The existence of an effective Ageing Management Programme (AMP), from conceptual design through to final decommissioning, can greatly assist in the periodic assessment of a facility.

Periodic review

A facility on a nuclear licensed site will undergo a periodic review of its status against current safety standards and expectations by the Nuclear Installations Inspectorate. The interval between reviews is currently no greater than every 10 years. The NII Safety Assessment Principles⁴⁶ set out the requirements and assessment process for safety assessments:

NII's assessment process consists of examining submissions from duty holders to enable a judgement to be made that risks are ALARP and that appropriate attention has been paid to aspects important to safety and to radioactive waste management and decommissioning. NII's assessment covers both normal operation and fault conditions, including internal and external hazards and human errors, all of which have the potential for causing the exposure of workers or the public to significant unplanned doses of ionising radiation or releases of radioactivity.

⁴⁴ <http://www.hse.gov.uk/nuclear/silicon.pdf>

⁴⁵ http://www-pub.iaea.org/MTCD/publications/PDF/P072_scr.pdf

⁴⁶ <http://www.hse.gov.uk/nuclear/saps/saps2006.pdf>

This review seeks to highlight any differences in comparison to modern standards. Following this an assessment can be carried out of whether it is reasonably practicable to address any differences. In addition to this NDA RWMD are currently undertaking a process to review the adequacy of historical LoCs.

Figure 13 - A systematic Ageing Management Programme (AMP)

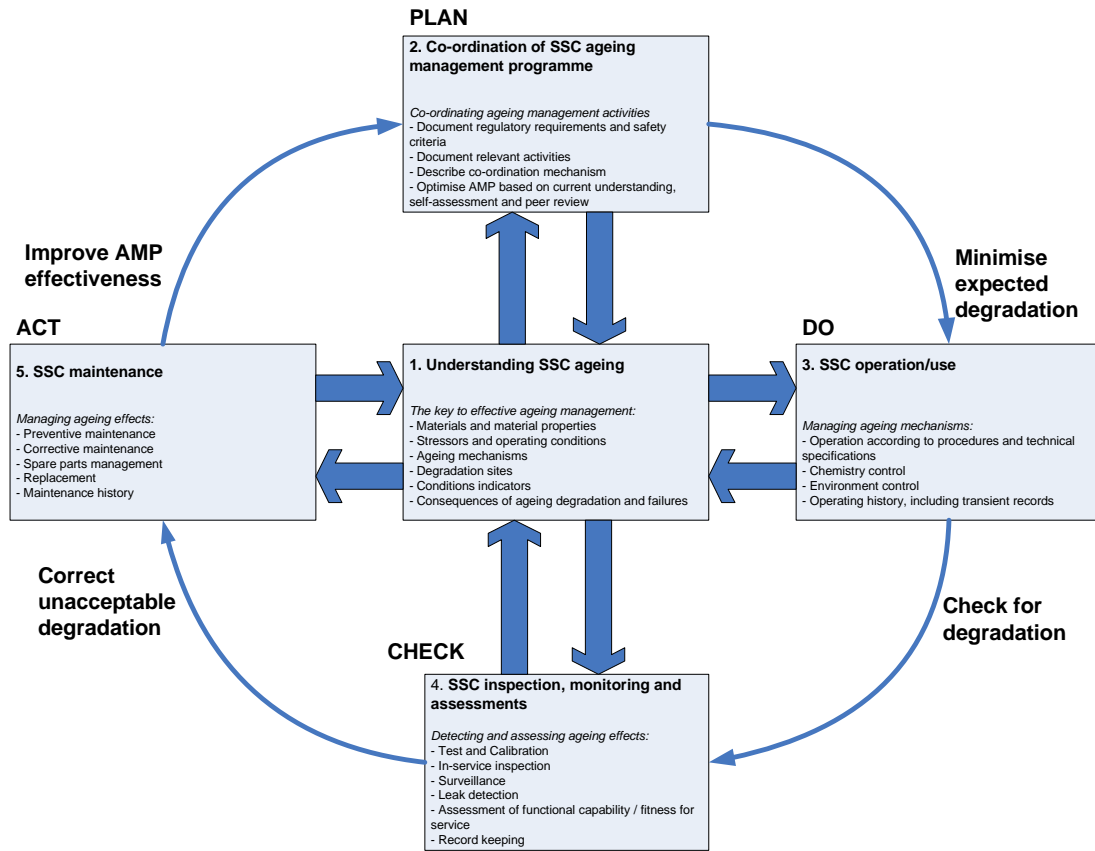
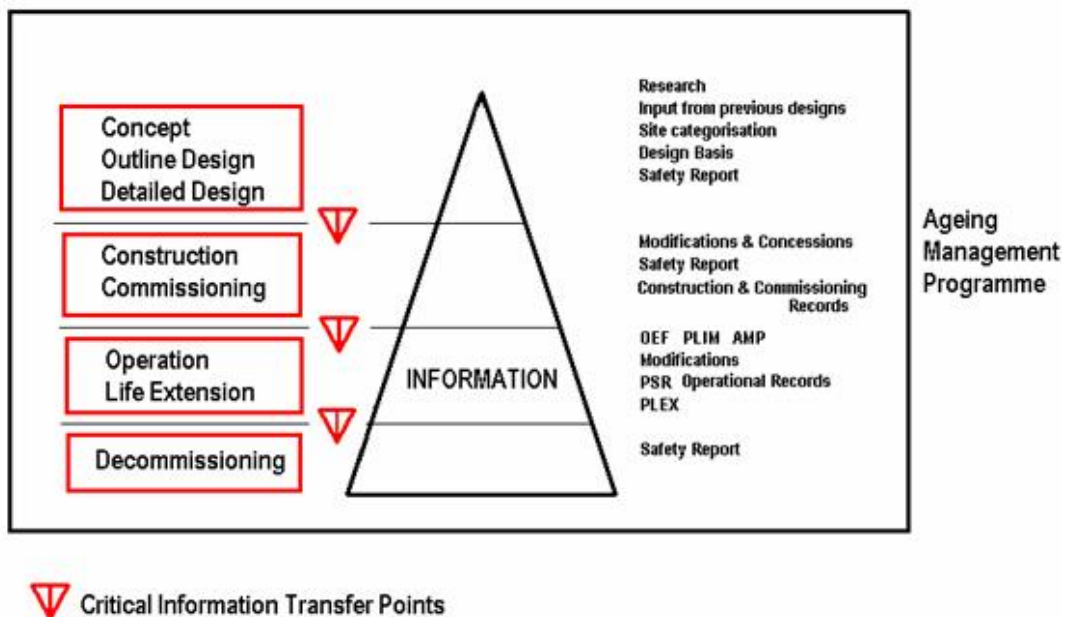


Figure 14 - Information Transfer during the Lifecycle of a facility⁴⁷



Critical Information Transfer Points

⁴⁷ http://www-pub.iaea.org/MTCD/publications/PDF/P072_scr.pdf

Appendix 3 - ILW package performance⁴⁸

In accordance with Government Policy and regulatory expectations, ILW and HLW packages being manufactured now are required to be suitable for interim storage and eventual geological disposal. This position is for stored material in England and Wales only.⁴⁹ Waste packages are being designed to meet requirements for passive safety and disposability. Recognising that waste packages will at some stage need to be transported, waste packages are also designed to be compatible with a planned future transportation system.

Throughout its lifetime the waste package has a central role in contributing to the safety of the public and work-force and to protection of the environment. This is reflected in the numerous safety cases which will be produced to cover the various stages in the waste package's life, from production, through storage and transport to eventual disposal. The various safety contributions can be summarised under the following broad headings; waste package mechanical strength, radiation shielding, containment and criticality. The waste package also has to remain identifiable and provide a physical link back to package records and quality management systems. NDA works with site operators to facilitate manufacture of waste packages which provide the necessary level of performance, however, it is known that this could be put at risk if waste packages do not evolve as predicted by underpinning research or if the container is subject to degradation due to for instance external factors such as poor environmental conditions.

As a consequence 'package care' is seen as a key imperative for NDA (and other waste owners). Waste packages need to satisfy safety case requirements throughout all stages of waste management otherwise this may lead to reworking or repackaging, which may have a significant impact on lifetime safety, environmental and cost factors. The NDA is working with site operators and Regulators to protect and care for the major investment represented by conditioned waste packages.

ILW packages have been manufactured in the UK since the early 1990s. These have been manufactured against packaging standards set down initially by Nirex, and latterly by the NDA RWMD. These packaging standards have been set based on an evaluation of the contribution that the waste package will make to the various safety cases that will be necessary throughout waste package life, culminating in emplacement in a geological disposal facility. As an example of the packaging standards refer to the Generic Waste Package Specification (GWPS).⁵⁰

The GWPS defines the standard features of each waste package, together with required performance characteristics such as integrity, heat loading, external dose rate, *etc.*, that will permit the waste package to be compliant with the safety cases as presently understood. This is an important point. RWMD does not yet have a site for the proposed GDF hence its safety cases for transport, operations and for the period post-closure, are generic and based on a concept that could, it is believed be implemented at any number of as yet undefined sites. As a consequence the packaging standards adopt a precautionary approach and include margins of safety to accommodate uncertainty with the eventual safety case. As the GDF project is taken forward, it is proposed that the waste packaging standards would adopt requirements from the real 'site-specific' safety cases enabling the margins to be re-evaluated.

The packaging standards also address issues such as the quality management system that should be applied to the process. The information that will be needed to be recorded and maintained regarding the waste package and contents.

⁴⁸ This appendix is a summary of a technical note issued by NDA entitled 'Approach to the Care of Waste Packages', number 9274090, November 2008

⁴⁹ Waste in Scotland will be stored at or near the point of arising

⁵⁰ Generic Waste Package Specification, Nirex Report N/104, March 2007.

The waste packaging standards do not specify materials of manufacture either for the waste container or for the waste conditioning matrix, preferring to leave these decisions to the waste packager. Instead the packaging standards state what is to be achieved based on criteria derived from the various safety cases. Typically waste containers are manufactured using corrosion resistant materials such as austenitic stainless steel, although other materials such as duplex stainless steel and ductile cast iron are also being considered. Conditioning matrices are chosen to provide a passive safe waste product which is also compatible with geological disposal. Selection of an appropriate conditioning process will be dictated by a number of factors including compatibility with waste and disposal environment chemistry, operability of the process, cost *etc.* Review of the proposed waste package and checking for compliance with the long-term management safety cases is undertaken by RWMD through the LoC assessment process.

'Package care' is important to NDA and other waste owners as this is the route to ensuring that the package continues to meet its safety and design functions throughout the various phases of waste management. The starting point is for the waste packager to understand how the package will evolve over time and how it will contribute to the various safety cases needed throughout the waste management phases. This process is aided by waste packaging standards defined by RWMD and by the LoC assessment process which provides advice to waste packagers as part of the package development process before the waste packages are actually manufactured.

Waste packages in interim storage should be monitored to ensure they are performing in line with safety case requirements and are evolving as predicted. Any adverse deterioration of packages during storage might impact the ability to demonstrate compliance with the transport safety case or waste acceptance criteria for the GDF.

Of particular concern are conditioned waste streams that contain relatively large amounts of chemically reactive species such as metallic Magnox, aluminium and uranium. As these materials corrode, the resultant oxide will occupy a greater volume than the original metallic form and this may lead to stresses within the wasteform and ultimately may lead to expansion or distortion. Guidance has been issued to limit the amount of such materials within a cemented wasteform, however if the wasteform evolves at a rate not predicted by the research, then the integrity of the waste package could be challenged. If remedial work is required it is likely to be costly, especially if it involves complete repackaging of the waste, and would have a direct impact on a site's LTP costs. More importantly there are safety and environmental implications, since waste products may not be compliant with safety case requirements, and would need to be doubled-handled to facilitate remediation or repackaging. This would have dose uptake implications for workers and any repackaging would lead to an increase in overall waste volume, both from the primary process and from subsequent decommissioning of any new asset.

Conditioned and packaged wastes that contain organic materials such as PVC are also of concern to the industry. There is the possibility that these materials may degrade during interim storage due to the possible effects of radiolysis and formation of corrosive agents that may limit the lifetime of the package. Mitigation for this effect is to have a double-skinned waste container which provides two containment barriers, however not all such packages have this defence-in-depth and those packages with only a single barrier will need to be checked periodically during storage to give confidence of no untoward behaviour. The independent Regulators are reviewing industry practices in this respect and have issued a scrutiny report on the topic.⁵¹

Most waste packages meet the safety criteria through the combined contributions of the conditioned wasteform and the waste container. This is not universally the case however as there are some wastes currently containerised but in an unconditioned form. Furthermore some new proposals envisage loading unconditioned wastes into robust waste containers where the safety functions are all provided by the enhanced waste container. The acceptability of conditioning proposals is assessed by RWMD through the LoC process discussed earlier.

⁵¹ Environment Agency, The longevity of intermediate level radioactive waste packages for geological disposal: A review, NWAT/Nirex/036/003, August 2008

Appendix 4 - -Security arrangements in the UK

Security in the civil nuclear industry is subject to regulation which reflects the United Kingdom's international obligations and best practice. In particular, the UK is a party to the Convention on the Physical Protection of Nuclear Material (CPPNM) and takes into account the recommendations made by the International Atomic Energy Agency (IAEA) in its document, 'The Physical Protection of Nuclear Material and Nuclear Facilities' (INFCIRC/225/ Rev4). These recommendations call for a competent national authority to be appointed which should have a 'clearly defined legal status and independence' and which is 'empowered to establish and ensure the proper implementation of the States system of physical protection'. OCNS is the UK's 'competent national authority' and independent regulator for the civil nuclear industry.

OCNS regulates the civil nuclear industry by means of the Nuclear Industries Security Regulations 2003 (NISR 03). NISR 03 requires nuclear licensed sites to have an approved Site Security Plans (SSPs). SSPs are protectively marked and they detail the standards, procedures and specific arrangements that must be kept in place to ensure the security of the nuclear premises, nuclear material in whatever category, form or quantity and sensitive nuclear information against the malicious capabilities posed by the Nuclear Industries Malicious Capabilities Planning Assumptions. This document allows a judgement to be made with regard to the malicious capabilities that could be deployed against a licensed site or transporters, and against which security measures should provide protection. It draws on intelligence provided by the national intelligence agencies particularly the Joint Terrorist Analysis Centre of which OCNS is a member.

Operators submit their SSPs to OCNS for approval before they are adopted and thereafter, they become the basis against which they are judged to be compliant with the regulations. Once approved SSPs are regarded as live documents and subject to constant review, scrutiny and amendment as necessary by the operator concerned and by OCNS through regulatory activity.

The security of nuclear material transported outside of licensed sites is covered in a similar manner using Transport Security Plans (TSPs) and Transport Security Statements (TSSs). Nuclear material should ideally spend the least possible time in transit and be subject to the least number of inter-modal changes.

OCNS Inspectors ensure that sites and transporters are compliant with their SSPs, TSPs and TSSs by carrying out programmed audits and no notice compliance inspections. In addition to ensuring that all security measures are in place and operating, Inspectors also ensure that there are robust procedures for the maintenance, testing and repair of the security infrastructure and they take particular note of modifications to existing buildings to ensure that existing security measures are not compromised.

Security measures in the civil nuclear industry are applied in a graduated manner in accordance with the severity of the threat and the level of consequence of a successful attack in a manner that provides defence in depth. They include physical, electronic, information and personnel security measures.

In his last annual report the Director, Civil Nuclear Security stated that security in the civil nuclear security was effective.

Appendix 5 – Store details

Table 4 - Existing and proposed stores at Sellafield

Store	Original/notional design life	Start of operation	Present baseline end of operation	Present baseline required service life	Extension capability indicated by operator	Comments
Encapsulated Product Store 1 - EPS1	50	1991	2060	59	Initial assessment by SLC indicates that an extension in service life is achievable of 41 years over its current baseline service life (<i>i.e.</i> total life of 100yrs+).	Site level project underway to specify asset care requirements to meet baseline. Availability of output and coverage in LTP to be confirmed by the SLC.
EPS2	50	1997	2066	69	Initial assessment by SLC indicates that an extension in service life is achievable of 31 years over its current baseline service life (<i>i.e.</i> total life of 100yrs+).	As EPS1
Engineered Drum Store 1 - EDS1	50	1992	2049	57	Initial assessment by SLC indicates that no practical life extension is available for EDS1.	Construction of a further EDS series store (EDS4) will be included in a LTP update. Relocation and conditioning of PCM waste will enable the emptying of EDS1.
EDS2	50	2001	2059	58	Initial assessment by SLC indicates that a 50 year life extension is possible for EDS2.	Site level project underway to specify asset care requirements to meet baseline. Availability of output and coverage in LTP to be confirmed by the SLC.
EDS3	100	2006	2065	59	EDS3 has a 100 year design life however SLC states that this is potentially extendable by a further 25 years.	Site level project underway to Site level project underway to specify asset care requirements to meet baseline. Availability of output and coverage in LTP to be confirmed by the SLC.
Waste Packaging and Encapsulation Plant Store - WPEPS	50	1994	2056	62	Initial assessment by SLC indicates that a 25 year life extension may be achievable.	As EDS3
AGR Dismantling Waste Store	50	1985	2052	55	Initial assessment by SLC indicates that a 25 year life extension may be achievable <i>i.e.</i> to 2060	As EDS3
AGR Dismantling Waste Store Extension	50	1998	2052	42	As above	As EDS3
Miscellaneous Beta Gamma Waste Store - MBGWS	50	1991	2049	49	Initial assessment by SLC has indicated that a 50 year life extension (to 2091) may be possible however this is likely to incur significant time and cost and hence may not be cost effective should it be required.	The store holds raw waste which is scheduled for removal and conditioning in 2040. The store emptying date is dependent on the availability of this new conditioning facility and availability of the GDF to minimise double handling.

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Store	Original/notional design life	Start of operation	Present baseline end of operation	Present baseline required service life	Extension capability indicated by operator	Comments
Vitrified Product Store - VPS	50	1990	2095	105	SLC has stated that life extension capability is minimal	SLC is in the process of updating the LTP to include a replacement facility.
EPS3	Civil = 100 years Mechanical = 50years	2011	2070	59	Initial assessment by SLC has indicated that the store life can be extended by 50 years subject to plant and equipment refurbishment and/or replacement together with the successful outcome of safety case reviews.	Site level project underway to specify asset care requirements to meet baseline. Availability of output and coverage in LTP to be confirmed by the SLC.
Box Encapsulation Plant Product Store 1 - BEPPS1	50	2013	2075	62	Initial assessment by SLC has indicated that the store life can be extended by 50 years subject to plant and equipment refurbishment and/or replacement together with the successful outcome of safety case reviews.	As EPS3
BEPPS2	Civil = 100 years Mechanical = 50years	2016	2081	65	Initial assessment by SLC has indicated that the store life can be extended by 50 years subject to plant and equipment refurbishment and/or replacement together with the successful outcome of safety case reviews.	As EPS3
BEPPS3	Civil = 100 years Mechanical = 50years	2019	2086	67	Initial assessment by SLC has indicated that the store life can be extended by 50 years subject to plant and equipment refurbishment and/or replacement together with the successful outcome of safety case reviews.	As EPS3
BEPPS4	Civil = 100 years Mechanical = 50years	2026	2091	65	Initial assessment by SLC has indicated that the store life can be extended by 50 years subject to plant and equipment refurbishment and/or replacement together with the successful outcome of safety case reviews.	As EPS3

Table 5 - Existing and proposed stores at Windscale

Store	Original / notional design life	Start of operation	Present baseline end of operation	Present baseline required service life	Extension capability indicated by operator	Comments
WAGR Store	50	2000	2045	45	Additional 50 years	The SLC has recently reviewed the design and revised the design life upwards to 100 years.
Pile Store	100+	2019	2042	23	Future store – yet to be designed and built therefore design life is flexible	

Table 6 - Existing and proposed stores at Dounreay

Store	Original/ notional design life	Start of operation	Present baseline end of operation	Present baseline required service life	Extension capability indicated by operator	Comments
DCP Store	100	1986 – original structure 2004 - extension	2066	80 years – original structure 62 years - extension	100 year design life – relocation of waste into newer extension.	Store design life exceeds baseline service life.
Drum and Box Store	100	2012	2067	55	Up to 100 year design life	Store design life exceeds baseline service life
4m Box Store	25	2014	2067	53	Additional 25 years for current facility	Current proposed plan is the conversion of this store from an LLW store to an ILW store (for shielded packages)

Table 7 - Existing and proposed stores at Magnox sites

Store	Original/notional design life	Start of operation	Present baseline end of operation	Present baseline required service life	Extension capability indicated by operator	Comments
Chapelcross	100	2014	2046	32	n/a – 100 year design life	<p>All store design lives exceed baseline requirements and meet the 100 year requirement.</p> <p>Berkeley store has a condition within its planning consent that states “The Intermediate Level Waste store hereby permitted, together, with all the waste stored therein shall be removed from the site within 3 years, or such longer period as may be agreed in writing with the Waste Planning Authority, of a national facility for the long term management of ILW or alternative means of off-site storage or disposal becoming available”</p> <p>Hinkley Point A store has a condition within its planning consent that states “The radioactive Waste Storage Building hereby permitted, together, with all waste stored therein shall be removed from the site within 3 years, or such longer period as may be agreed in writing by the County Planning Authority, of a national facility for the long term management of ILW or other alternative means of off-site storage or disposal becoming available”.</p> <p>Trawsfynydd store has a condition within its planning consent that states “The ILW store hereby permitted, together with all waste stored therein, shall be removed from the site within 3 years, or such longer period as may be agreed in writing by the local planning authority, of a national facility for the long term management of ILW or other alternative means of off-site storage or disposal becoming available.”</p>
Hunterston A	100	2008	2046	38	n/a – 100 year design life	
Trawsfynydd	150	2008	2042	34	n/a – 150 year design life	
Oldbury	100	2019	2047	28	n/a – 100 year design life	
Berkeley	150	2010	2049	39	n/a – 150 year design life	
Bradwell	100	2012	2045	33	n/a – 100 year design life	
Dungeness A	100	2016	2042	26	n/a – 100 year design life	
Hinkley Point A	100	2012	2050	38	n/a – 100 year design life	
Sizewell A	100	2014	2048	34	n/a – 100 year design life	

Table 8 - Existing and proposed stores at Research Sites

Store	Original/notional design life	Start of operation	Present baseline end of operation	Present baseline required service life	Extension capability indicated by operator	Comments
Harwell Vault Store	50	1998	2048	50	Additional 50 years	Store meets the baseline service life
Winfrith Treated Radwaste Store	20	2006	2042	36	The SLC has judged that the lifetime of this store could be extended to around 2100 if necessary	Store lifetime has been extended following recent site reviews
Harwell ILW Store	50	2013	2060	47	The SLC has indicated that as both stores are not yet designed or constructed they could be designed and built to achieve a 100 year lifetime if required. Design lives quoted are based solely on the planning assumption of geological disposal facility availability in 2040.	
Winfrith 2m ILW Box Store	20	2024	2043	20		

Table 9 - Existing and proposed stores at British Energy Sites

Store	Original/notional design life	Start of operation	Present baseline end of operation	Present baseline required service life	Extension capability indicated by operator	Comments
Dungeness B	50	2021	2040	19	All BE stores exceed the required baseline service life however they are all assumed to have a 50 year design life. With the exception of the Sizewell B store (which is already constructed) all of the stores are future build and could be designed and built to meet the 100 year target. NDA will be working with BE to review this position.	
Hartlepool	50	2017	2040	23		
Heysham 1	50	2017	2040	23		
Heysham 2	50	2026	2040	14		
Hinkley Point B	50	2019	2040	21		
Hunterston B	50	2019	2040	21		
Torness	50	2026	2040	14		
Sizewell B	50	Mid 1990's	2040	~50		

Appendix 6 – Glossary

Abbreviation	Description	Abbreviation	Description
AGR	Advanced Gas-Cooled Reactor	MOP	Magnox Operating Programme
British Energy	British Energy's	MoU	Memorandum of Understanding
BPEO	Best Practicable Environmental Option	MOX	Mixed Oxide
CCP	Cartridge Cooling Pond	MRWS	Managing Radioactive Waste Safely
C&M	Care and Maintenance	OED	Ongoing Environmental Detriment
CHP	Chemical Hazard Potential	NDA	Nuclear Decommissioning Authority
CHILW	Contact handled intermediate level waste	NII	Nuclear Installations Inspectorate
CoRWM	Committee on Radioactive Waste Management	NNA	National Nuclear Archive
CPPNM	Convention on the Physical Protection of Nuclear Material	NNL	National Nuclear Laboratory
DCP	Dounreay Cementation Plant	NSG	National Stakeholder Group
DfT	Department for Transport	OCNS	Office for Civil Nuclear Security
DSR	Design Safety Report	PCM	Plutonium Contaminated Material
DSRL	Dounreay Sites Restoration Ltd	PCSC	Post Closure Safety Case
ESC	Early Site Clearance	POCO	Post-Operative Clean Out
ESS	Early Safe Store	PSR	Periodic Safety Review
FD	Facility Descriptor	PWR	Pressurised Water Reactor
FED	Fuel Element Debris	RHP	Radiological Hazard Potential
FSC	Final Site Clearance	R&D	Research and Development
GDF	Geological Disposal Facility	RSRL	Research Sites Restoration Ltd
HAL	Highly Active Liquor	RWMD	Radioactive Waste Management Directorate
HALES	Highly Active Liquor Evaporation & Storage	SED	Safety and Environmental Detriment score
HASTs	Highly Active Liquor Storage Tanks	SGHWR	Steam Generating Heavy Water Reactor
HAW	Higher Activity Waste	SLC	Site Licence Company
HLW	High Level Waste	SMS	Strategy Management System
IAEA	International Atomic Energy Agency	SSPs	Site Security Plans
ILW	Intermediate Level Waste	SWTC	Standard Waste Transport Container
INS	International Nuclear Services	TSPs	Transport Security Plans
IWS	Integrated Waste Strategy	TSSs	Transport Security Statements
KPI	Key Performance Indicator	UKAEA	United Kingdom Atomic Energy Authority
LoC	Letter of Compliance	WAC	Waste Acceptance Criteria
LLW	Low Level Waste	WAGR	Windscale Advanced Gas-cooled Reactor
LLWR	Low Level Waste Repository	WETP	Waste Encapsulation Treatment Plant
LTP	Life Time Plan	WNMM	Waste and Nuclear Materials Management
MoD	Ministry of Defence	WUD	Waste Uncertainty Descriptor