Radioactive Waste Management

NDA Report no. DSSC/404/01

Geological Disposal

Derived Inventory: Scenarios Report

December 2016

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Preface

Radioactive Waste Management Limited (RWM) has been established as the delivery organisation responsible for the implementation of a safe, sustainable and publicly acceptable programme for the geological disposal of the higher activity radioactive wastes in the UK. As a pioneer of nuclear technology, the UK has accumulated a legacy of higher activity wastes and material from electricity generation, defence activities and other industrial, medical and research activities. Most of this radioactive waste has already arisen and is being stored on an interim basis at nuclear sites across the UK. More will arise in the future from the continued operation and decommissioning of existing facilities and the operation and subsequent decommissioning of future nuclear power stations.

Geological disposal is the UK Government's policy for higher activity radioactive wastes. The principle of geological disposal is to isolate these wastes deep underground inside a suitable rock formation, to ensure that no harmful quantities of radioactivity will reach the surface environment. To achieve this, the wastes will be placed in an engineered underground facility – a geological disposal facility (GDF). The facility design will be based on a multi-barrier concept where natural and man-made barriers work together to isolate and contain the radioactive wastes.

To identify potentially suitable sites where a GDF could be located, the Government has developed a consent-based approach based on working with interested communities that are willing to participate in the siting process. The siting process is on-going and no site has yet been identified for a GDF.

Prior to site identification, RWM is undertaking preparatory studies which consider a number of generic geological host environments and a range of illustrative disposal concepts. As part of this work, RWM maintains a generic Disposal System Safety Case (DSSC). The generic DSSC is an integrated suite of documents which together give confidence that geological disposal can be implemented safely in the UK.

Executive Summary

The Nuclear Decommissioning Authority (NDA) through Radioactive Waste Management Ltd (RWM) is responsible for implementing UK Government policy for the long-term management of higher activity radioactive wastes. The UK Government's framework for 'Implementing Geological Disposal' is set out in the 2014 Implementing Geological Disposal White Paper and defines the inventory for disposal in a geological disposal facility (GDF). RWM has developed a quantified description of this inventory called the 'Derived Inventory'.

The 2013 Derived Inventory[1] provides the volumes and radioactivities of higher activity wastes and other materials categories considered in the planning assumptions for the GDF. Data are presented for High Level Waste, Intermediate Level Waste, some Low Level Waste unsuitable for near-surface disposal, spent fuel, depleted natural and low-enriched uranium, highly enriched uranium and plutonium. In addition, the inventory is broken down into more detailed waste groups that have been defined by RWM to distinguish between different types of waste for its design and assessment studies and to reflect key differences in the time of arising, waste packaging and assumed emplacement in the GDF.

The 2013 Derived Inventory presents information that is based on the best available data and assumptions regarding, for example, the timing and size of a new build programme. Inevitably there are uncertainties associated with the data and some of the assumptions are better underpinned than others. As part of the 2013 Derived Inventory update RWM has explored sensitivity to changes in assumptions and uncertainties in the data by considering a range of inventory scenarios.

This report documents the sensitivity of the 2013 Derived Inventory to a number of different scenarios that have the potential to impact on RWM's design and safety cases. These are examined quantitatively or qualitatively, as required. Any assumptions used in constructing the scenarios are set out, and the changes to 2013 Derived Inventory volumes, package numbers and total radioactivities for each of the detailed waste groups are presented.

Uncertainties in volume and radioactivity have the greatest impact, and this impact is dominated by a small number of waste streams.

1 Radioactive Waste Management, *Geological Disposal: The 2013 Derived Inventory*, DSSC/403/01, 2016.

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1 Introduction

1.1 The generic Disposal System Safety Case

RWM has been established as the delivery organisation responsible for the implementation of a safe, sustainable and publicly acceptable programme for geological disposal of the UK's higher activity radioactive waste. Information on the approach of the UK Government and devolved administrations of Wales and Northern Ireland[2] to implementing geological disposal, and RWM's role in the process, is included in an overview of the generic Disposal System Safety Case (the Overview) [1].

A geological disposal facility (GDF) will be a highly-engineered facility, located deep underground, where the waste will be isolated within a multi-barrier system of engineered and natural barriers designed to prevent the release of harmful quantities of radioactivity and non-radioactive contaminants to the surface environment. To identify potentially suitable sites where a GDF could be located, the Government is developing a consent-based approach based on working with interested communities that are willing to participate in the siting process [2]. Development of the siting process is ongoing and no site has yet been identified for a GDF.

In order to progress the programme for geological disposal while potential disposal sites are being sought, RWM has developed illustrative disposal concepts for three types of host rock. These host rocks are typical of those being considered in other countries, and have been chosen because they represent the range that may need to be addressed when developing a GDF in the UK. The host rocks considered are:

- higher strength rock, for example, granite
- lower strength sedimentary rock, for example, clay
- evaporite rock, for example, halite

The inventory for disposal in the GDF is defined in the Government White Paper on implementing geological disposal [2]. The inventory includes the higher activity radioactive wastes and nuclear materials that could, potentially, be declared as wastes in the future. For the purposes of developing disposal concepts, these wastes have been grouped as follows:

- High heat generating wastes (HHGW): that is, spent fuel from existing and future power stations and High Level Waste (HLW) from spent fuel reprocessing. High fissile activity wastes, that is, plutonium (Pu) and highly enriched uranium (HEU), are also included in this group. These have similar disposal requirements, even though they don't generate significant amounts of heat.
- Low heat generating wastes (LHGW): that is, Intermediate Level Waste (ILW) arising from the operation and decommissioning of reactors and other nuclear facilities, together with a small amount of Low Level Waste (LLW) unsuitable for near surface disposal, and stocks of depleted, natural and low-enriched uranium (DNLEU).

RWM has developed six illustrative disposal concepts, comprising separate concepts for HHGW and LHGW for each of the three host rock types. Designs and safety assessments for the GDF are based on these illustrative disposal concepts.

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2 Hereafter, references to Government mean the UK Government including the devolved administrations of Wales and Northern Ireland. Scottish Government policy is that the long term management of higher activity radioactive waste should be in near-surface facilities and that these should be located as near as possible to the site where the waste is produced.

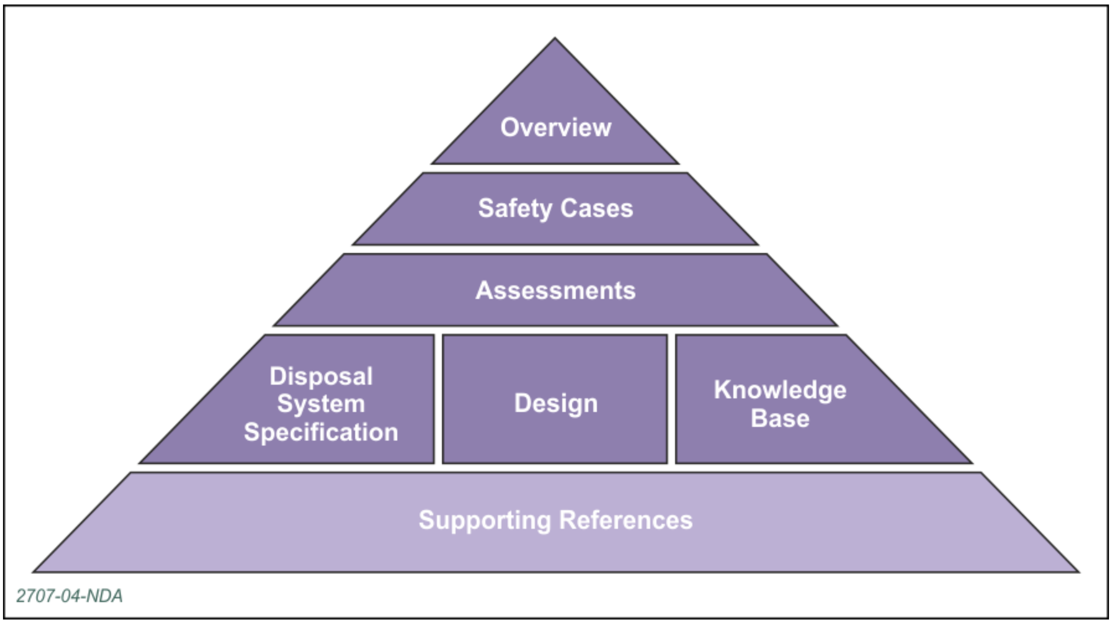
High level information on the inventory for disposal, the illustrative disposal concepts and other aspects of the disposal system is collated in a technical background document (the Technical Background) [3] that supports this generic Disposal System Safety Case.

The generic Disposal System Safety Case (DSSC) plays a key role in the iterative development of a geological disposal system. This iterative development process starts with the identification of the requirements for the disposal system, from which a disposal system specification is developed. Designs, based on the illustrative disposal concepts, are developed to meet these requirements, which are then assessed for safety and environmental impacts. An ongoing programme of research and development informs these activities. Conclusions from the safety and environmental assessments identify where further research is needed, and these advances in understanding feed back into the disposal system specification and facility designs.

The generic DSSC provides a demonstration that geological disposal can be implemented safely. The generic DSSC also forms a benchmark against which RWM provides advice to waste producers on the packaging of wastes for disposal.

Document types that make up the generic DSSC are shown in Figure 1. The Overview provides a point of entry to the suite of DSSC documents and presents an overview of the safety arguments that support geological disposal. The safety cases present the safety arguments for the transportation of radioactive wastes to the GDF, for the operation of the facility, and for long-term safety following facility closure. The assessments support the safety cases and also address non-radiological, health and socio-economic considerations. The disposal system specification, design and knowledge base provide the basis for these assessments. Underpinning these documents is an extensive set of supporting references. A full list of the documents that make up the generic DSSC, together with details of the flow of information between them, is given in the Overview.

Figure 1 Structure of the generic DSSC



1.2 Introduction to the derived inventory alternative scenarios

This document is the derived inventory alternative scenarios report.

The generic DSSC was previously published in 2010. There are now a number of drivers for updating the safety case as an entire suite of documents, most notably the availability of an updated inventory for disposal.

This document, the derived inventory alternative scenarios report, is new to the generic DSSC and explores the impact of different inventory scenarios. The wastes and other materials for geological disposal are defined in broad terms in Government policy [2]. For its design and assessment work, RWM requires a more detailed, quantitative definition. This detailed definition of the quantities and characteristics of wastes and materials for geological disposal is known as the derived inventory.

The 2013 Derived Inventory [4] is based on a single scenario for the arisings of wastes and materials for geological disposal and their conditioning and packaging. The alternative scenarios that are defined and analysed in this report address uncertainties in data and changes in assumptions that have the potential to influence the inventory for disposal.

In order to explore uncertainty, the 2007 and 2010 derived inventories [5, 6] included an ‘upper inventory’ that was compiled to allow the implications of uncertainty to be explored in RWM’s design and safety and environmental assessment work. The ‘upper inventory’ was not intended to be a maximum estimate, or to set out the largest inventory that could be safely disposed of in the GDF. The scenario based approach presented in this report replaces the ‘upper inventory’ approach.

This report is a companion to the 2013 Derived Inventory report; it presents detailed technical information and is targeted at an audience of scientists and engineers, in particular RWM staff and contractors who will use this information in generic GDF design and assessment work to support the process of implementing geological disposal.

1.3 Objective

The objective of the work on alternative scenarios for the derived inventory is to produce information about the potential impact on the derived inventory of uncertainties in data (for example, about waste volumes and activities) and changes to assumptions (for example, about the size and composition of a new build programme). Some of the information presented is quantitative and some qualitative.

1.4 Scope

1.4.1 Issues addressed in scenarios

The scenarios that have been studied address a number of potential issues that include:

- possible changes to operational plans (for example, the operational lifetimes of the reprocessing plants and existing reactors)
- the uncertainties in the data (for example, the uncertainties specified by the waste producers in the 2013 UK RWI [7])
- the disposal of the products from the management of separated plutonium
- changes to the compositions and / or size of a UK new build programme
- wastes that might be excluded from the inventory for disposal

The scenarios deal only with key changes to waste quantities, waste characteristics and assumptions. RWM recognises that the list of scenarios is not an exhaustive list of scenarios and if, at a later date, RWM identifies further scenarios of importance then these will be assessed and reported.

1.4.2 Analysis of each scenario

Each scenario is treated in one of four ways: fully quantitatively; semi-quantitatively; by providing some quantitative information that could be used to study the scenario in the future; or qualitatively.

1.4.3 Precision

Consistent with the 2013 Derived Inventory, data in this report are presented to three significant figures (where possible). As a result of the rounding, some tables will show totals that may not represent the sum of the rounded data within the tables. Instead, the totals represent the sum of the data rounded to three significant figures. This approach ensures an appropriate and consistent level of precision in all of the data.

1.4.4 Hazardous substances and non-hazardous pollutants

RWM uses the UK RWI as the basis for producing its Derived Inventory and at present the UK RWI contains little information on hazardous substances and non-hazardous pollutants. Therefore the 2013 Derived Inventory does not specifically quantify hazardous substances and non-hazardous pollutants and the uncertainty associated with them is not explored further in this report. As a consequence of this RWM's safety cases do not provide detailed quantified assessments of the safety and environmental impacts of hazardous substances and non-hazardous pollutants.

1.5 Document Structure

The remainder of this report is structured as follows:

- Section 2 provides a description of the scenarios that RWM has considered
- Section 3 presents an analysis of each of the scenarios
- Section 4 presents a summary of the results of the scenario analysis
- Section 5 presents the conclusions

In addition, there are two appendices that provide further detail:

- Appendix A gives the detailed assumptions and a description of the method for each of the scenarios that have been studied quantitatively
- Appendix B presents the data tables for materials, waste containers and activities at 2200

2 Scenarios

2.1 Description

Assessing all of the possible changes in assumptions and uncertainties in data in individual scenarios would be impractical. RWM has adopted the pragmatic approach of only including scenarios that highlight key changes in the waste quantities, waste characteristics or assumptions.

Table 1 summarises the issues addressed in the twelve scenarios that RWM has defined, and the corresponding assumptions in the 2013 Derived Inventory. RWM recognises that this is not an exhaustive list of scenarios and if, at a later date, RWM identifies further scenarios of importance then these will be assessed and reported.

Table 1 Summary of variant considered in each of the scenarios

No.	2013 Derived Inventory (DI) assumption	Variant considered in scenario
1	4,500 tU Advanced gas-cooled reactor (AGR) spent fuel (SF) and 1,050 tU pressurised water reactor (PWR) SF not reprocessed	Reprocessing more oxide fuels from existing civil reactors
2	All Magnox SF reprocessed	Reprocessing less Magnox SF
3	Reactors operate until regulator approved date	Extensions to reactor operational lifetimes
4a	UK RWI reference volume used	Use of UK RWI lower uncertainty volume
4b	UK RWI reference volume used	Use of UK RWI upper uncertainty volume
4c	UK RWI reference activity used	Use of UK RWI lower uncertainty activity
4d	UK RWI reference activity used	Use of UK RWI upper uncertainty activity
5	95% of civil Pu (and all defence Pu) disposed of as mixed oxide (MOX) SF	Disposal of Pu in other forms
6	No LLW comes to the GDF from the Low Level Waste Repository (LLWR)	Likelihood and consequences for the DI of removal of some LLW from LLWR and disposal in the GDF
7	Depleted natural & low-enriched uranium (DNLEU) arisings as specified by material owners	Change in quantities of DNLEU disposed
8	16 GW(e) new build programme	Change in composition and / or size of new build programme
9	No foreign wastes / materials included	Likelihood and consequences for the DI of inclusion of foreign wastes and materials
10	2013 DI packaging assumptions	Potential alternative waste packaging scenarios
11	Graphite wastes are included	Exclusion of graphite wastes
12	LLW boundary wastes are included	Exclusion of ILW / LLW boundary wastes

Scenario 1: Reprocessing more oxide fuel

Oxide fuel refers to the UO_2 that is used as fuel in the AGR reactors and the Sizewell B reactor (and is also assumed to be used in any new build reactors). Fuel from the AGR reactors is currently reprocessed at the Thermal Oxide Reprocessing Plant (THORP) but this is due to cease in about 2018 leaving some AGR fuel unreprocessed. The issue addressed in this scenario is reprocessing additional AGR spent fuel and also the spent oxide fuel from Sizewell B.

Scenario 2: Reprocessing less Magnox fuel

The 2013 Derived Inventory assumes that all of the Magnox spent fuel is reprocessed. The issue addressed in this scenario is the possibility that some Magnox fuel is not reprocessed.

Scenario 3: Lifetime extensions for existing reactors

EDF has successfully applied for extensions to the operating lifetimes of some of its reactors. In this scenario the possibility of lifetime extensions being granted to EDF's other reactors is considered.

Scenario 4: Use of UK RWI uncertainty factors

The UK RWI includes estimates of the uncertainties in the volumes and specific activity of the wastes. In both cases, upper and lower uncertainty factors are provided. This scenario is about the implications of using these uncertainty factors. Four sub-scenarios are considered:

a. lower volume uncertainty
b. upper volume uncertainty
c. lower activity uncertainty
d. upper activity uncertainty

Scenario 5: Products of management of plutonium

The UK Government's policy is that plutonium should be reused in the form of mixed oxide (MOX) fuel. However, only when the UK Government is confident that this could be implemented safely, securely and in a way that offers value for money will it be in a position to proceed [8]. To inform the Government decision on whether to do so, NDA has work in progress on various options for the long-term management of separated plutonium. This scenario is about the potential implications of these options for the inventory for geological disposal.

Scenario 6: Removal of some LLW from the LLWR

The issue addressed by this scenario is whether LLW might be removed from the older part of the LLWR and disposed of in the GDF.

Scenario 7: Change in quantities of DNLEU for geological disposal

The depleted uranium (DU) tails arising from the enrichment of uranium form the bulk of the DNLEU inventory. Based on discussions with URENCO, the UK RWI contains an estimate of the arisings of DU from enrichment activities. This estimate is based on an assumed lifetime for the enrichment plant and any change to this assumption would affect the quantity of DU arising. It is also possible that alternative long-term management options will be adopted for some DNLEU. This scenario is about such potential changes to the inventory of DNLEU disposed in the GDF.

Scenario 8: Change in new build programme

The current stated industry ambition for new nuclear development is 16 GW(e) [2]. This is not a Government target and the UK Government is supportive of industry bringing forward plans for further development in future. In the 2013 Derived Inventory it is assumed, for simplicity, that the 16 GW(e) is provided by six UK EPRs and six AP1000s. This scenario is about the implications of changes to the composition and / or size of the new build programme.

Scenario 9: Inclusion of foreign wastes and materials

UK Government general policy is that radioactive waste should not be imported to or exported from the UK except in specifically defined and limited circumstances [9]. The issues addressed in this scenario are the likelihood that foreign wastes or materials would be accepted for geological disposal in the UK and the implications if they were.

Scenario 10: Alternative packaging assumptions

The volume of the inventory for disposal will depend on the way in which the waste is conditioned and packaged. The impact of potential changes to the waste conditioning and packaging assumptions in the 2013 Derived Inventory is considered in this scenario.

Scenario 11: Exclusion of graphite wastes

The baseline strategy for reactor decommissioning graphite is geological disposal. Other options for the disposal of such graphite wastes are being studied and in this scenario the implications of excluding them from the GDF are examined.

Scenario 12: Exclusion of ILW / LLW boundary wastes

The 2013 UK RWI includes 42 ILW streams that waste producers expect to manage as LLW through near-surface disposal by using radioactive decay storage and / or decontamination processes. These streams are referred to as ILW / LLW boundary wastes. Some combustible wastes are expected to be incinerated and some metal wastes are expected to be recycled. Only those ILW / LLW boundary streams where there is an established decontamination or incineration process were excluded from the 2013 Derived Inventory. The issue addressed in this scenario is the exclusion of all ILW / LLW boundary wastes from the GDF.

3 Analysis

Each of the scenarios outlined in Section 2 is considered in a sub-section below. Each scenario is treated in one of four ways: fully quantitatively; semi-quantitatively; by providing some quantitative information that could be used to study the scenario in the future; or qualitatively.

For each scenario, a detailed description is provided, along with a justification for the type of study that is carried out. Where appropriate, the high level assumptions for the scenario are then given along with the results of the analysis. Where appropriate, a detailed methodology is provided in Appendix A.

Where calculations have been carried out, these have been undertaken for the waste groups identified in the 2013 Derived Inventory which, for reference, are repeated in Table 2. The waste groups have been defined to distinguish between different types of waste and to reflect key differences in time of arising, packaging and assumed emplacement in the GDF. As such, the waste groups are not fixed and could change. Highly enriched uranium has been included with the HHGW rather than the LHGW owing to similarities in its packaging and assumed emplacement in the GDF.

Because the objective of this report is to highlight the sensitivity of the inventory to changes in the scenario, the results are reported for the 2013 Derived Inventory values and the scenario values. Only those waste groups that have changed are included in the results tables and charts presented in the sub-sections below.

The presentation of the results described above allows for the impact of the scenarios to be described. However, caution should be exercised when combining scenarios as this may result in an inconsistent set of assumptions.

Table 2 The waste groups used for the presentation of the inventory for disposal in a GDF

<table>
<tr><th></th><th>Waste groups</th><th>Subdivision</th></tr>
<tr><td rowspan="6">LHGW</td><td>Legacy shielded ILW and LLW (SILW / SLLW)</td><td></td></tr>
<tr><td>Legacy unshielded ILW and LLW (UILW/ ULLW)</td><td></td></tr>
<tr><td>Robust shielded ILW containers (RSCs)</td><td></td></tr>
<tr><td>Depleted natural & low-enriched uranium (DNLEU)</td><td></td></tr>
<tr><td>New build shielded ILW (SILW)</td><td></td></tr>
<tr><td>New build unshielded ILW (UILW)</td><td></td></tr>
<tr><td rowspan="9">HHGW</td><td>HLW</td><td></td></tr>
<tr><td>Plutonium</td><td></td></tr>
<tr><td>Highly enriched uranium</td><td></td></tr>
<tr><td rowspan="4">Legacy spent fuel</td><td>AGR</td></tr>
<tr><td>Exotics (PFR)</td></tr>
<tr><td>Metallic (legacy ponds)</td></tr>
<tr><td>Sizewell B PWR</td></tr>
<tr><td>New build spent fuel</td><td></td></tr>
<tr><td>MOX spent fuel</td><td></td></tr>
</table>

3.1 Scenario 1: Reprocessing more oxide fuel

There are three main types of reactor in the UK, and spent fuel from each is handled differently. Currently, spent fuel from Magnox reactors is reprocessed, spent fuel from AGRs is either reprocessed or stored pending decisions about its future disposal, and spent fuel from PWRs is stored pending decisions about its future disposal. Consistent with this, the 2013 Derived Inventory assumes that 4,500 tU of AGR spent fuel, all Sizewell B spent fuel and all new build spent fuel remain once all stations have been shut down and reprocessing has been completed.

Reprocessing of more oxide fuel would reduce the spent fuel inventory and lead to an increased inventory of operational ILW, HLW, low-enriched uranium and plutonium. However, most radionuclide activities would be relatively unchanged[3]. It is estimated that reprocessing all of the oxide spent fuel from Sizewell B and the AGRs would result in a very small increase (< 1 %) in the overall packaged volume, and a decrease in the number of legacy HHGW waste packages of around 20 %.

This scenario does not align with the decisions of NDA or EDF and is therefore considered to be a low likelihood. Changes to the assumptions on reprocessing in the 2013 Derived Inventory would not present any new challenges (the radionuclide inventory would not change significantly and no new waste types would be introduced). As a result, this scenario is not discussed in any more detail.

[3] The activities of volatile species will be lower (eg C14 / I129) as some of this inventory is discharged during reprocessing.

3.2 Scenario 2: Reprocessing less Magnox fuel

The 2013 Derived Inventory assumes that there will be 55,000 tU of Magnox spent fuel, and the current UK policy is that all Magnox spent fuel will be reprocessed. The aim is to complete Magnox reprocessing by December 2020 [10]. Should the Magnox reprocessing plant not remain operational for long enough to complete spent fuel reprocessing, this would have the following impacts on the inventory for disposal:

- there would be a reduction in the quantity of depleted uranium, HLW and operational ILW associated with the reprocessing
- the quantity of MOX spent fuel would reduce as less separated plutonium would be available for reuse
- the quantity of metallic spent fuel would increase

This scenario is considered quantitatively because

- the characteristics of the Magnox spent fuel are different to those of the products of reprocessing
- the total packaged volume of the legacy spent fuel will be significantly affected since the assumed method of packaging the Magnox spent fuel is not as efficient as the packaging of the wastes from reprocessing

3.2.1 Assumptions

The 2013 Derived Inventory assumes that a total of 55,000 tU of Magnox spent fuel will be reprocessed. At 1st April 2013, 52,000 tU of Magnox spent fuel had been reprocessed [7]. The bounding assumption for this scenario is therefore that 3,000 tU of Magnox spent fuel is not reprocessed. This assumption has been made in order to maximise the potential impact on the inventory for disposal. It is assumed that the Magnox spent fuel would be packaged in the same way as the metallic spent fuel in the 2013 Derived Inventory.

The calculations for this scenario are based on the same supporting assumptions as those in the 2013 Derived Inventory and details are presented in Appendix A1.

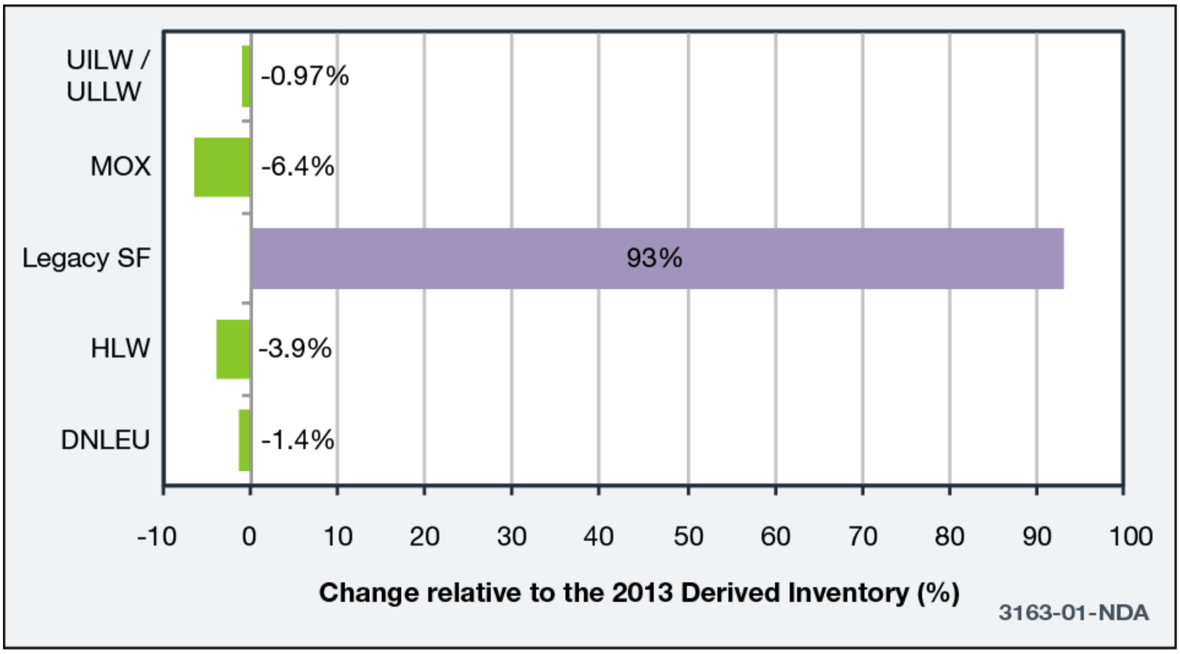
3.2.2 Volumes and package numbers

The impact of not reprocessing 3,000 tU of Magnox spent fuel on the number of packages and packaged volumes is indicated in Table 3 for the affected waste groups. The packaged volume has increased by 6,470 m^3, while the number of packages has fallen by 2,570. These represent changes of just under 1% in the 2013 Derived Inventory values. Whilst the overall changes are not significant, the change in the legacy spent fuel waste group is significant: both the packaged volume and the number of packages roughly double. The changes to the packaged volumes are illustrated in Figure 2.

Table 3 The number of packages and the packaged volume for those waste groups affected by Scenario 2

Waste group	Number of packages		Packaged volume (m^3)	
	2013 DI	Scenario 2	2013 DI	Scenario 2
UILW / ULLW	197,000	191,000	327,000	323,000
HLW	2,400	2,310	9,290	8,930
Legacy SF	3,610	7,000	14,800	28,500
MOX SF	2,710	2,530	11,900	11,200
DNLEU	31,000	30,900	217,000	214,000
Total	236,000	234,000	580,000	586,000

Figure 2 The percentage change in packaged volume for those waste groups affected by Scenario 2



3.2.3 Activities

The total activity associated with the 2013 Derived Inventory at 2200 is 27,300,000 TBq; based on the assumptions outlined in Section 3.2.1 the total activity at 2200 for this scenario is 27,200,000 TBq. There is little difference in the activity at 2200, despite the fact that the quantity of MOX spent fuel has been reduced.

Table 4 The activities of the priority 1 radionuclides at 2200 for all waste groups in the 2013 Derived Inventory (DI) and Scenario 2

Nuclide	Activity (TBq)		Change
	2013 DI	Scenario 2	
C14	17,600	17,900	+2%
Cl36	114	114	< +1%
Co60	2.12	2.12	< -1%
Se79	96.8	96.1	< -1%
Kr85	1,250	1,250	< -1%
Tc99	19,100	19,300	< +1%
I129	42.1	42.7	+2%
Cs135	919	917	< -1%
Cs137	5,040,000	5,040,000	< +1%
U233	2.51	2.70	+7%
U235	53.8	53.7	< -1%
U238	2,560	2,560	< -1%
Np237	837	834	< -1%

Table 4 compares the total activity of the priority 1 radionuclides at 2200 in the 2013 Derived Inventory and this scenario; the percentage change is also presented. It can be seen that the overall impact of this scenario on the activity associated with any of the priority 1 radionuclides is small. Table B34 presents the activities of the priority 1 radionuclides at 2200 by waste group; information is only presented for those waste groups that have changed.

3.2.4 Material component data

Three sets of data are presented for this scenario:

- data for materials in the waste are presented in Table B1
- data for conditioning and capping materials are presented in Table B2
- data for materials in the waste containers are presented in Table B3

Overall the waste material mass has decreased by 3,510 t, the conditioning and capping material mass has decreased by 2,600 t, while the waste container mass has increased by 64,800 t.

3.3 Scenario 3: Lifetime extensions for existing reactors

EDF has successfully applied for lifetime extensions for some of its reactors and is in the process of applying for life extensions for the remaining reactors. If granted, the lifetime extensions would result in an increase in both the radionuclide inventory and the volume of waste in both ILW and spent fuel. Because of this, this scenario is studied quantitatively.

3.3.1 Assumptions

The assumed lifetime extensions for the AGRs and the Sizewell B PWR are shown in Table 5; these extensions have been chosen to allow an indication of the potential impact on the inventory and are subject to change. The lifetime extensions are also applied to the care and maintenance and final site clearance dates. The additional wastes associated with the lifetime extensions have been estimated from average annual arisings of operational wastes [11]. Details of the calculation for this scenario are presented in Appendix A2.

Table 5 The assumed lifetime extensions to the existing reactors[4]

Station	Reactor type	Extension (years)
Dungeness B	AGR	10
Heysham 1	AGR	9
Heysham 2	AGR	9
Sizewell B	PWR	20

3.3.2 Volumes and package numbers

The impact of the lifetime extensions on the numbers of packages and the packaged volumes are indicated in Table 6. The packaged volume has increased by 5,780 m^3 and the number of packages has increased by 1,700. These changes represent increases of less than 1% in the 2013 Derived Inventory values.

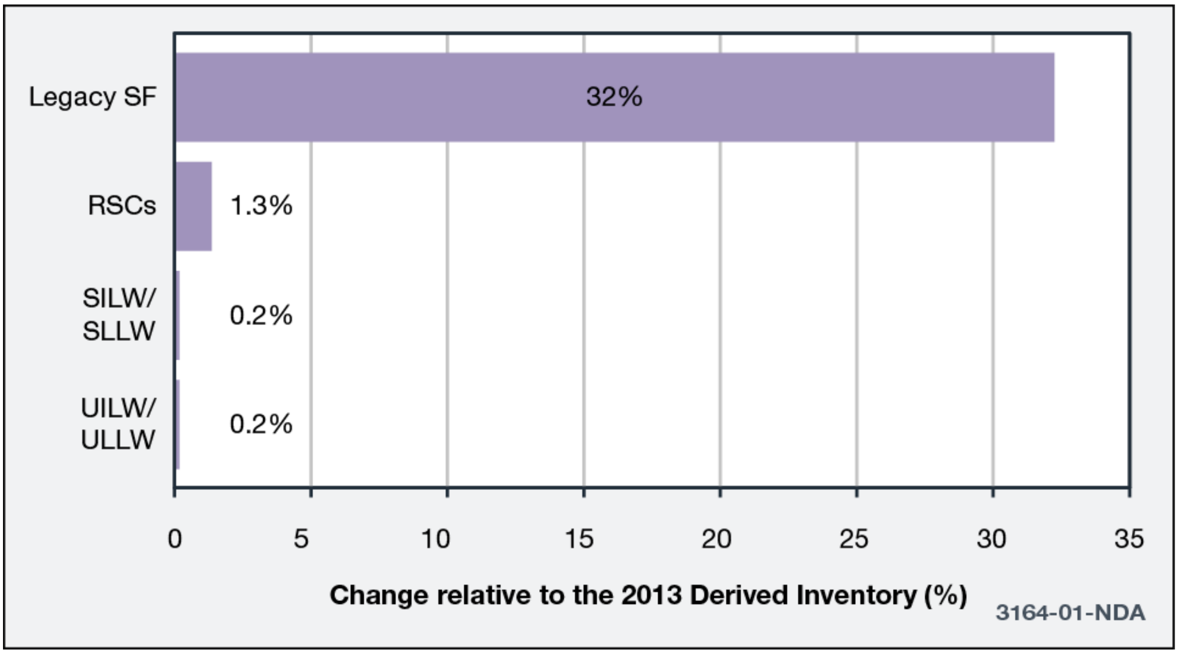
Figure 3 illustrates the percentage change in packaged volume for the waste groups affected by scenario 3. The impact of the scenario is largest for legacy spent fuel.

Table 6 The number of packages and the packaged volume for those waste groups affected by Scenario 3

Waste group	Number of packages		Packaged volume (m^3)	
	2013 DI	Scenario 3	2013 DI	Scenario 3
UILW / ULLW	197,000	197,000	327,000	327,000
SILW / SLLW	4,850	4,860	93,000	93,100
RSCs	2,270	2,350	7,280	7,380
Legacy SF	3,610	4,770	14,800	19,500
Total	207,000	209,000	442,000	447,000

4 Since the publication of the 2013 Derived Inventory Dungeness B has been granted a 10 year lifetime extension. EDF has also announced (on 16th February 2016) further lifetime extensions for AGR reactors: 5 years for Heysham 1 and Hartlepool; 7 years for Heysham 2 and Torness.

Figure 3 The percentage change in packaged volume for those waste groups affected by Scenario 3



3.3.3 Activities

The total activity associated with the 2013 Derived Inventory and this scenario at 2200 is shown in Table 7. As would be expected, there is an increase in the total activity associated with the inventory for disposal if the operational lifetimes of existing reactors are extended. Table 7 shows that the overall activity increase associated with the scenario at 2200 would be around 4.5%, based on the assumptions outlined in Section 3.3.1.

Table 7 Total activities for all waste groups

	2200 Activity (TBq)
2013 DI	27,300,000
Scenario 3	28,500,000

Table 8 presents the activities of the priority 1 radionuclides at 2200 for all waste groups for the 2013 Derived Inventory and this scenario, the percentage change is also presented. Table B35 presents the activities of the priority 1 radionuclides at 2200 by waste group; information is only presented for those waste groups that have changed. The impact of this scenario on the waste group activities is largest for the legacy spent fuel waste group.

Table 8 **The activities of the priority 1 radionuclides at 2200 for all waste groups in the 2013 Derived Inventory (DI) and Scenario 3**

Radio-nuclide	2013 DI (TBq)	Scenario 3 (TBq)	Change
C14	17,600	17,900	+2%
Cl36	114	116	+1%
Co60	2.12	2.13	< +1%
Se79	96.8	103	+6%
Kr85	1,250	1,270	+2%
Tc99	19,100	20,000	+4%
I129	42.1	44.9	+7%
Cs135	919	974	+6%
Cs137	5,040,000	5,250,000	+4%
U233	2.51	2.71	+8%
U235	53.8	55.0	+2%
U238	2,560	2,590	+1%
Np237	837	870	+4%

3.3.4 Material component data

Three sets of data are presented for this scenario:

- data for materials in the waste are presented in Table B4
- data for conditioning and capping materials are presented in Table B5
- data for materials in the waste containers are presented in Table B6

Overall the waste material mass has increased by 3,700 t, the conditioning and capping material mass has increased by 538 t and the waste container mass has increased by 27,700 t.

3.4 Scenario 4: Use of UK RWI uncertainty factors

The UK RWI presents uncertainties in both the volume of the waste and the specific activity of each radionuclide in the waste. From these, the following inventories can be created:

a. lower uncertainty volume
b. upper uncertainty volume
c. lower uncertainty activity
d. upper uncertainty activity

Since this represents the waste producers' best estimate of the uncertainty in the inventory, it is considered important to study this scenario quantitatively.

3.4.1 Assumptions

Four sub-scenarios are considered, as outlined above. In each case, the appropriate UK RWI uncertainty factor is applied to the 2013 Derived Inventory data. Since uncertainty factors are only available for waste streams in the UK RWI, this scenario only affects HLW, UILW / ULLW, SILW / SLLW and RSC waste groups.

Details of the calculation for this scenario are presented in Appendix A3.

3.4.2 Volumes and package numbers

Figure 4 illustrates the percentage contributions from individual waste streams to the decrease in packaged volume associated with lower volume uncertainty factors. Five waste streams (from a total of 535) contribute 47% of this volume decrease:

- UILW stream 2D116 at Sellafield (Miscellaneous Plants Initial/Interim Decommissioning: Processing Plants, Tanks, Silos, etc)
- UILW stream 2D137 at Sellafield (Miscellaneous Plants Final Decommissioning: Processing Plants, Tanks, Silos, etc)
- SILW stream 9H311 at Wylfa (Final Dismantling & Site Clearance : Graphite ILW)
- UILW stream 2S302 at Windscale (Windscale Pile1 and Pile 2 Graphite and Aluminium Charge Pans)
- SLLW stream 9H315 at Wylfa (Final Dismantling & Site Clearance: Graphite LLW)

Figure 4 Waste stream percentage contribution to the reduced packaged volume associated with lower volume uncertainty (Scenario 4a)

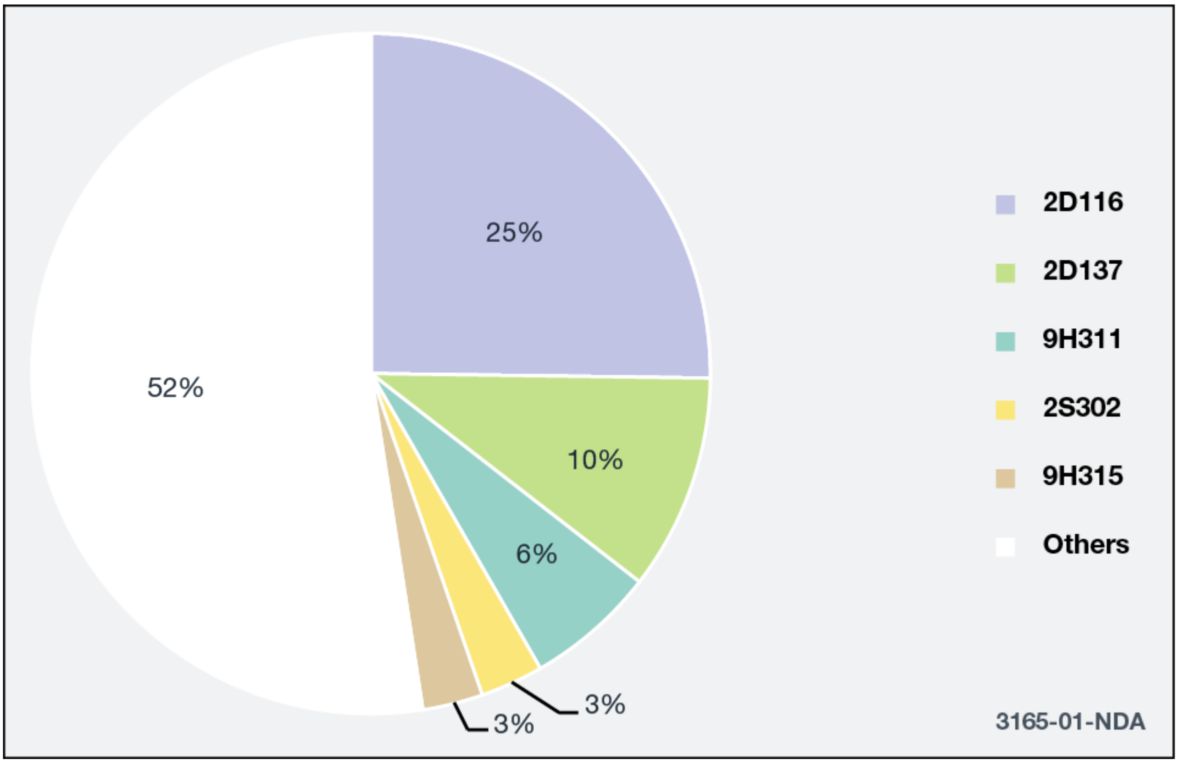


Figure 5 illustrates the percentage contributions from individual waste streams to the additional packaged volume associated with upper volume uncertainty factors. Five waste streams (from a total of 535) contribute 74% of this volume increase:

- UILW stream 2D116 at Sellafield (Miscellaneous Plants Initial/Interim Decommissioning: Processing Plants, Tanks, Silos, etc)
- UILW stream 2D137 at Sellafield (Miscellaneous Plants Final Decommissioning: Processing Plants, Tanks, Silos, etc)
- HLW stream 2F38/C at Sellafield (Vitrified High Level Waste from POCO)
- SILW stream 9H311 at Wylfa (Final Dismantling & Site Clearance : Graphite ILW)
- UILW stream 7A111 at Aldermaston (Decommissioning Waste PCM[5] ILW)

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5 Plutonium contaminated material (PCM).

Figure 5 **Waste stream percentage contribution to the additional packaged volume associated with upper volume uncertainty (Scenario 4b)**

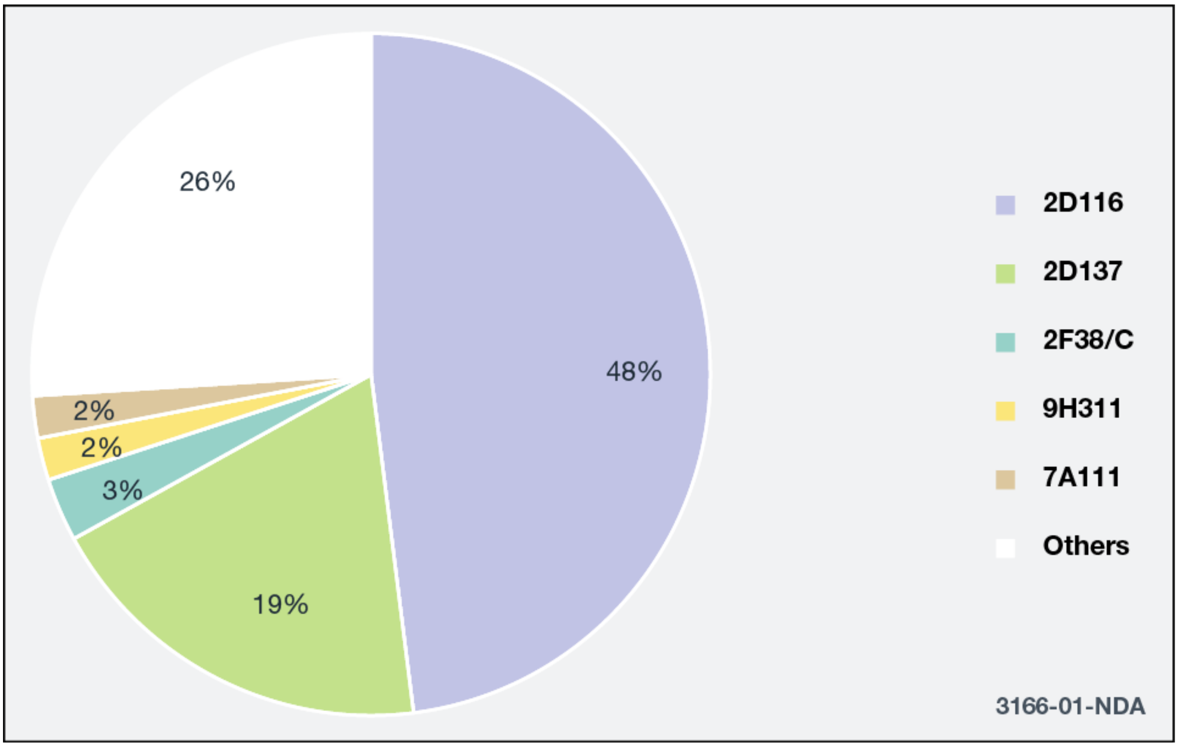


Figure 4 and Figure 5 show that the uncertainty in the packaged volume is dominated by a small number of waste streams. 2D116 and 2D137 are two of the largest waste streams in the inventory by volume. Wastes in these streams are generated from a number of decommissioning projects which will commence several years from now and run for many decades. As a result of this, minimal characterisation of the waste volumes and fingerprints has been carried out at present and hence there is a large uncertainty in the potential arisings. The combination of large initial volumes and large uncertainties means that these streams are significant contributors to both the upper and lower volume uncertainty.

The impact of applying volume uncertainty factors on the numbers of packages and packaged volumes is given in Table 9. This shows that applying lower uncertainty factors to waste volumes decreases the packaged volume by 106,000 m^3 and the number of packages by 38,500. Applying upper uncertainty factors to waste volumes increases the packaged volume by 372,000 m^3 and the number of packages by 131,000.

Table 9 **The number of packages and the packaged volume for those waste groups affected by Scenario 4**

Waste group	Number of packages			Packaged volume (m^3)		
	2013 DI	Lower	Upper	2013 DI	Lower	Upper
UILW / ULLW	197,000	161,000	322,000	327,000	256,000	651,000
SILW / SLLW	4,850	3,190	6,570	93,000	60,700	127,000
RSCs	2,270	1,970	2,640	7,280	6,210	8,560
HLW	2,400	1,860	5,640	9,290	7,210	21,800
Total	206,000	168,000	337,000	436,000	330,000	808,000

3.4.3 Activities

Figure 6 illustrates the percentage contributions from individual waste streams to the decrease in activity associated with lower uncertainty factors. Seven waste streams (from a total of 535) contribute 82% of this activity decrease:

- HLW stream 2F01/C at Sellafield (Vitrified HLW)
- HLW 2D02/C at Sellafield (Vitrified HLW - Magnox)
- UILW stream 2F08 at Sellafield (AGR stainless steel fuel assembly components)
- UILW stream 2F03/C at Sellafield (Encapsulated AGR cladding)
- UILW streams 3K30 at Hartlepool (Miscellaneous activated components and fuel stringer debris)
- UILW streams 3N38 at Hinkley Point B (Miscellaneous activated components and fuel stringer debris)
- UILW streams 3L25 at Heysham 1 (Miscellaneous activated components and fuel stringer debris)

The change in activity associated with applying lower uncertainty factors is dominated by HLW waste streams 2F01/C and 2D02/C. This is because, although these waste streams have a lower activity uncertainty factor of 1.5, they also have high total activities. By comparison, many of the ILW waste streams have a higher uncertainty factor but because they have a lower activity associated with them, their contribution to the overall activity reduction is not as significant.

Figure 7 illustrates the percentage contributions from individual waste streams to the increase in activity associated with upper uncertainty factors. Five waste streams (from a total of 535) contribute 91% of this activity increase:

- UILW stream 3S306 (Sizewell B decommissioning stainless steel ILW)
- UILW stream 3K30 (AGR station miscellaneous activated components and fuel stringer debris)
- UILW stream 3N38 (AGR station miscellaneous activated components and fuel stringer debris)
- UILW stream 3L25 (AGR station miscellaneous activated components and fuel stringer debris)
- UILW stream 2F08 at Sellafield (AGR stainless steel fuel assembly components)

The upper activity uncertainty is dominated by a single waste stream (3S306), which has a low total activity, but an uncertainty factor of 1000 for each radionuclide present. Few other waste streams have an uncertainty factor of 1000 for any radionuclide and as a result waste stream 3S306 dominates the upper activity uncertainty. The three other significant contributors to the upper activity (3L25, 3K30 and 3N38) all have an upper activity uncertainty factor of 100 for each radionuclide present. These uncertainty factors bound the maximum activities and are not a realistic estimate of the possible maximum activities. Carrying out analysis to reduce the uncertainty in these waste streams such that the uncertainty factors give a realistic representation of the possible range of activities would significantly reduce the uncertainty in the 2013 Derived Inventory.

The overall activity uncertainty associated with the wastes from existing facilities is dominated by a small number of waste streams: four waste streams (2F08, 3K30, 3L25 and 3N38) are significant contributors to both the upper and lower activity uncertainties, while one waste stream contributes nearly 60% of the upper activity uncertainty.

Figure 6 **Waste stream percentage contribution to the reduced total activity associated with lower activity uncertainty Scenario 4c**

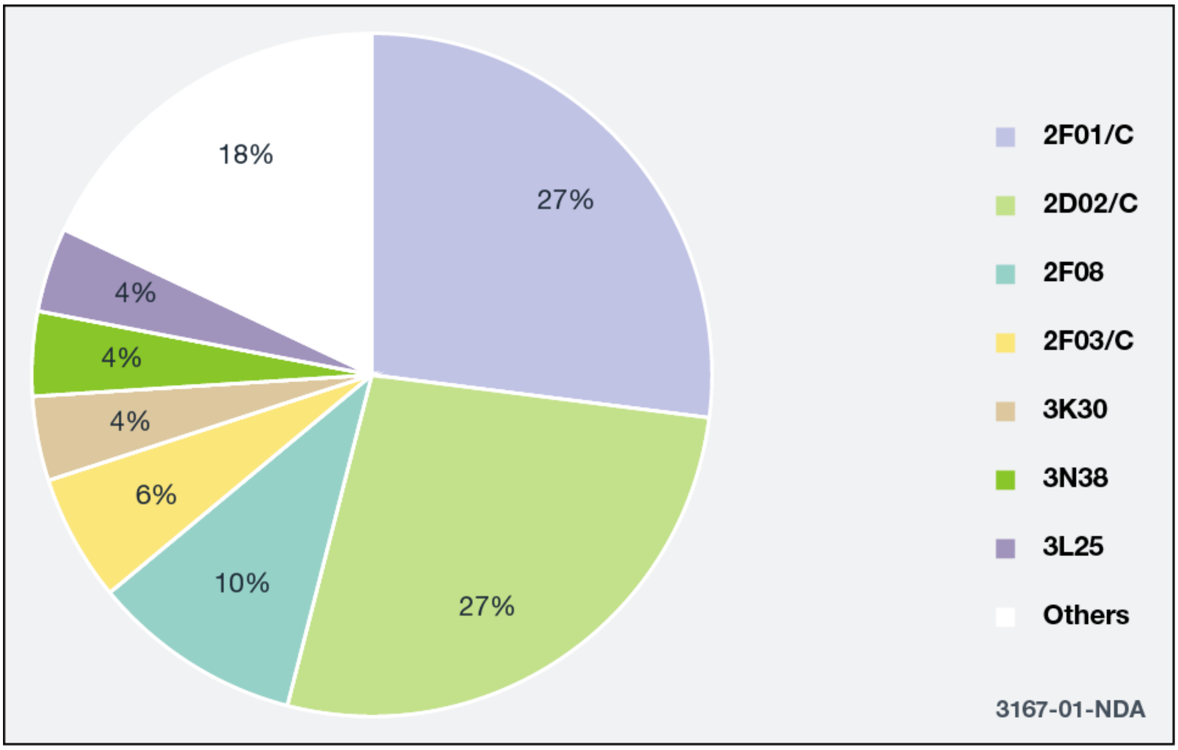
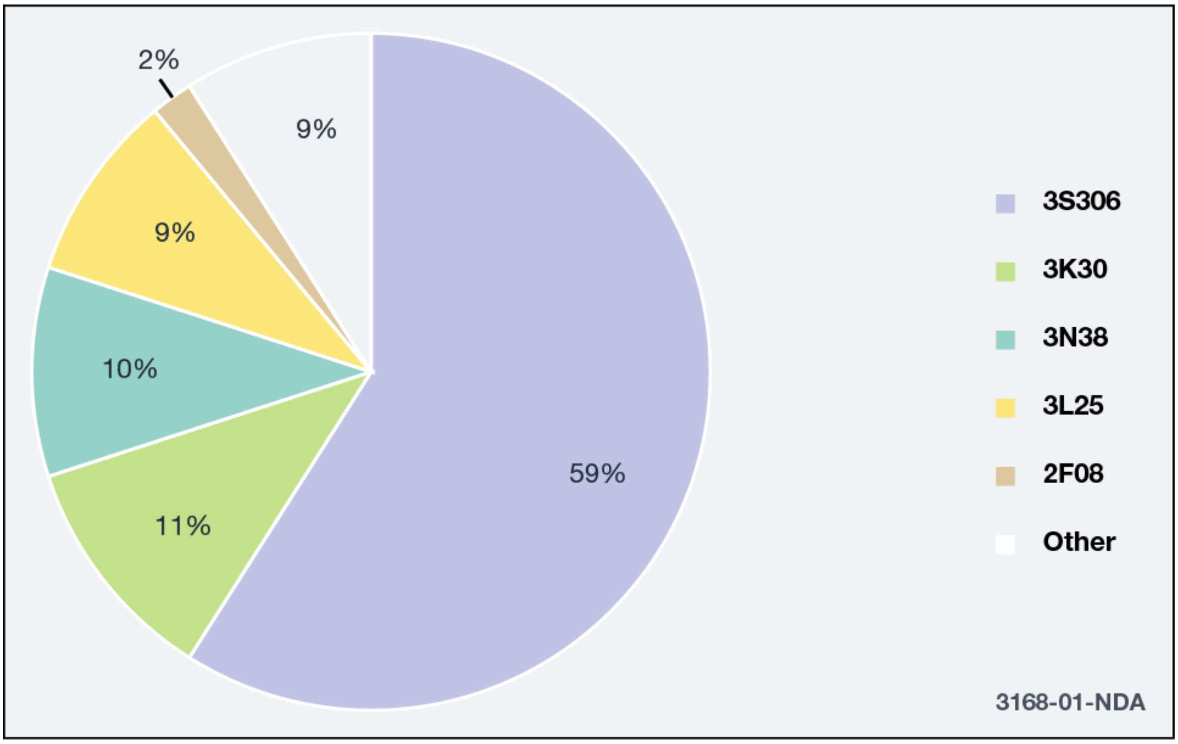


Figure 7 **Waste stream percentage contribution to the additional total activity associated with upper activity uncertainty Scenario 4d**



The overall impact of applying lower and upper uncertainty factors on the activity is given in Table 10. This shows that applying lower uncertainty factors to radionuclide activities decreases the activity at 2200 by 668,000 TBq (-3%). Applying upper uncertainty factors to radionuclide activities increases the activity at 2200 by 26,900,000 TBq (+100%).

Table 10 Total activities for all waste groups

	2200 Activity (TBq)
2013 DI	27,300,000
Lower	26,600,000
Upper	54,200,000

The impact of applying lower and upper uncertainty factors on the activity of the priority 1 radionuclides is given in Table 11. For each of the priority 1 radionuclides only a small number of waste streams contribute to the change in activity associated with the lower and upper uncertainty factors. The waste streams contributing the most to the changes in activity for the priority 1 radionuclides are set out beneath Table 11.

Table 11 The total activities of the priority 1 radionuclides at 2200 for all waste groups in the 2013 Derived Inventory (DI) and Scenario 4

Radionuclide	2013 DI	Lower		Upper	
		Activity (TBq)	Change	Activity (TBq)	Change
C14	17,600	10,900	-40%	120,000	x 6
Cl36	114	83.0	-30%	442	x 3
Co60	2.12	2.12	< -1%	2.44	+15%
Se79	96.8	91.1	-6%	106	+9%
Kr85	1,250	1,250	<-1%	1,250	< +1%
Tc99	19,100	17,800	-7%	27,100	+40%
I129	42.1	41.6	-1%	44.4	+6%
Cs135	919	853	-7%	1,020	+10%
Cs137	5,040,000	4,950,000	-2%	5,190,000	+3%
U233	2.51	1.61	-40%	5.46	x 2
U235	53.8	53.4	< -1%	55.5	+3%
U238	2,560	2,550	< -1%	2,600	+2%
Np237	837	738	-10%	1,410	+70%

The waste streams contributing the most to the changes in activity for the priority 1 radionuclides are:

- C14 – Magnox and AGR graphite decommissioning streams with uncertainty factors of 10 and waste stream 3S306 (Sizewell B decommissioning stainless steel ILW) with uncertainty factors of 1,000
- Cl36 – Magnox and AGR graphite decommissioning streams with uncertainty factors of 10 and waste stream 3S306 (Sizewell B decommissioning stainless steel ILW) with uncertainty factors of 1,000
- Co60 – 3J24 (Desiccants ILW) with uncertainty factors of 100
- Se79 – 2D02/C (Vitrified HLW – Magnox) and 2F01/C (Vitrified HLW) with uncertainty factors of 1.5

- Kr85 – 2F03/C (Encapsulated AGR Cladding) and 2D24 (Magnox Cladding and Miscellaneous Solid Waste) with uncertainty factors of 3 and 1.5
- Tc 99 – 2D27/C (Encapsulated Floc from Effluent Treatment) and 2F01/C (Vitrified High Level Waste) with uncertainty factors of 100 and 1.5
- I129 – 2D21 (Stored Miscellaneous Beta/Gamma Active Solid Waste) with a lower uncertainty factor of 100 and an upper uncertainty factor of 10; 2D27/C (Encapsulated Floc from Effluent Treatment) and 2F06/C (Encapsulated Barium Carbonate Slurry/MEB[6] Crud) with uncertainty factors of 100 and 1.5
- Cs135 – 2D02/C (Vitrified HLW – Magnox) and 2F01/C (Vitrified HLW) with uncertainty factors of 1.5
- Cs137 – 2D02/C (Vitrified HLW – Magnox) and 2F01/C (Vitrified HLW) with uncertainty factors of 1.5
- U233 – 5C50 (Dragon Fuel) with uncertainty factors of 3 and 5C30 (Harwell Remote Handled ILW) with a lower uncertainty factor of 10 and an upper uncertainty factor of 3
- U235 – 2D42 (Magnox Pond Furniture) with uncertainty factors of 100, 2D96.2 (FGMSP Pond Solid Waste to BEP) with a lower uncertainty factor of 5 and an upper uncertainty factor of 10; and 2D38/C (Encapsulated Magnox Cladding) with uncertainty factors of 3
- U238 – 2D42 (Magnox Pond Furniture) with uncertainty factors of 100, 2D34 (Sludge from Sand Filters and Transfers) with uncertainty factors of 3; and 2D38/C (Encapsulated Magnox Cladding) with uncertainty factors of 3
- Np237 – 2D27/C (Encapsulated Floc from Effluent Treatment) and 2F10/C (Encapsulated Centrifuge Cake) with uncertainty factors of 10 and 3

Table B36 presents the activities of the priority 1 radionuclides at 2200 by waste group; information is only presented for those waste groups that have changed.

3.4.4 Material component data

Six sets of data are presented for the scenario; three for the lower volume uncertainty and three for the upper volume uncertainty:

- data for materials in the waste are presented in Table B7 and Table B10
- data for conditioning and capping materials are presented in Table B8 and Table B11
- data for materials in the waste containers are presented in Table B9 and Table B12

For the lower volume uncertainty scenario the waste material mass has decreased by 69,700 t while the conditioning and capping material mass has decreased by 84,800 t and the waste container mass has decreased by 58,300 t.

For the upper volume uncertainty scenario the waste material mass has increased by 135,000 t while the conditioning and capping material mass has increased by 385,000 t and the waste container mass has increased by 232,000 t.

[6] Multi-element bottle (MEB).

3.5 Scenario 5: Products of management of plutonium

UK Government's preliminary preferred policy for the long-term management of plutonium has been published [8]. Consistent with this, the 2013 Derived Inventory assumes that the vast majority of the plutonium inventory will be reused in the form of mixed oxide (MOX) fuel, and any remaining plutonium whose condition is such that it could not be converted into MOX would be immobilised and treated as waste for disposal. This assumption nevertheless recognises that the UK Government has not made any decision on the fate of the UK's plutonium stocks and the NDA continues to support Government in developing a strategy for separated plutonium [12].

The NDA has identified three credible options for plutonium [13]:

- long-term storage (followed by disposal)
- immobilisation and direct disposal
- re-use as fuel

In the context of the inventory for disposal, following storage the two types of long-term management options for separated plutonium are (a) immobilisation and treatment as a waste and (b) reuse [8, 12, 13]. These are discussed briefly below.

Immobilisation and treatment as a waste

In the absence of a published policy for the management of plutonium, the 2007 and 2010 Derived Inventories [5, 6] assumed that plutonium would be immobilised in a titanium-based ceramic and loaded into stainless steel cans, which are in turn encapsulated in glass within a large steel canister (the can-in-canister approach)[7].

The NDA's Position Paper 'Progress on approaches to the management of separated plutonium' identifies immobilisation through hot isostatic pressing (HIP) [13]. The HIP product is a ceramic and it is assumed that it would be disposed of in a disposal container similar to those used for HHGW.

Reuse

The reference case is for reuse of the plutonium stocks as MOX fuel in Light Water Reactors (LWRs). The NDA has also concluded that disposition of plutonium through reuse in an Enhanced CANDU 6 (EC6) reactor remains a credible option, as does reuse in a GEH PRISM fast reactor. Further details can be found in 'Progress on approaches to the management of separated plutonium'.

The quantity of spent fuel arising from any of the reuse as fuel options will be limited by the quantity and suitability of the plutonium stockpile. The nature of the spent fuel could impact on disposal and RWM will manage this through the disposability assessment process as required by NDA to support strategic studies on behalf of Government. It is assumed that the spent fuel would be disposed of in containers similar to those used for other HHGW. The quantity of spent fuel in a single disposal container would be limited by its thermal characteristics and residual fissile content.

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[7] This approach has been adopted for the plutonium not suitable for reuse in MOX fuel in the 2013 Derived Inventory.

3.6 Scenario 6: Removal of some LLW from the LLWR

In their 2011 Environmental Safety Case (ESC) [14], LLWR concluded that no intrusive remediation of the trenches would be required as part of their future site development plan. The Environment Agency's review of LLWR's 2011 ESC [15] did not raise any specific objections to LLWR's proposal on this matter. Consistent with LLWR's conclusion, the 2013 Derived Inventory does not include an allowance for any LLW from the LLWR being retrieved for disposal to the GDF.

This scenario does not align with current intentions and is therefore considered to have a low likelihood. In addition to this, any changes to the activity or volume of the inventory for disposal that would arise as a result of this scenario would be bounded by the uncertainty in the UK RWI wastes, discussed in Section 3.4. As a result, this scenario is not discussed in any more detail.

3.7 Scenario 7: Changes in quantities of DNLEU for geological disposal

Table 12 shows the composition of the DNLEU in the inventory for disposal and it is clear that depleted uranium (DU) tails that arise from enrichment activities are the dominant component. Magnox depleted uranium (MDU) and THORP product uranium (TPU) arise from the reprocessing of spent Magnox and oxide fuels, respectively. The quantity of DNLEU in the inventory for disposal would change if, for example, the assumptions regarding the enrichment of uranium or the operational lifetime of the reprocessing plants changed.

There is not a single set of packaging assumptions for DNLEU[8] in the Derived Inventory and so the impact of changes to the DNLEU inventory will depend on the waste stream that has changed. Table 12 presents the number of waste packages, the packaged volume and the total activity (at 2200) that is associated with a tonne of uranium in each of the waste streams. This enables changes to the quantity of DNLEU in the inventory for disposal to be calculated.

Table 12 Breakdown of the DNLEU in the 2013 Derived Inventory

DNLEU waste stream	Quantity (tU)	No. of waste packages / tU	Packaged volume (m^3) / tU	Total activity at 2200 / tU
MDU (earlier arisings)	23,100	0.12	3.62	4.89 10^{-2}
MDU (later arisings)	14,900	0.04	0.99	4.89 10^{-2}
TPU	5,000	1.03	0.59	4.53 10^{-2}
DU from defence enrichment	15,000	1.03	0.59	5.94 10^{-2}
DU tails (unirradiated)	108,500	0.03	0.85	3.97 10^{-2}
DU tails (irradiated)	15,500	0.03	0.85	6.01 10^{-2}
Miscellaneous DNLEU	3,000	1.03	0.59	5.08 10^{-2}

The aim is to complete Magnox reprocessing by December 2020, while THORP will close in 2018. Most of the DNLEU that will arise from these plants has already arisen and, as a result, it is not anticipated that the quantity of DNLEU associated with these streams would change significantly. Similarly, it is not anticipated that there will be any further arisings of miscellaneous DNLEU or DU from defence enrichment.

Disposal is not the only option for DNLEU. At this time, the NDA holds its uranics at a nil value pending development of long-term options and cost estimates. A future NDA assessment may ascribe a value or a liability to each type of uranic material.

The NDA is assessing the high level credible options for the management of the uranics which are: continued storage, recycle, or disposal [16]. Given the variety of types of uranics, it is anticipated that no single strategic option will be suitable for the entire uranics inventory.

In addition to the NDA's uranics, URENCO owns depleted uranium (DU) tails arising from the enrichment of uranium. Based on discussions with URENCO, the UK RWI estimates the arisings of DU from enrichment activities. This estimate is based on an assumed lifetime for the enrichment plant and any change to the plant's lifetime would have an impact on the inventory of DU.

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8 Some streams are assumed to be grouted into 500 l drums, while the other streams will be grouted into 'transport and disposal containers' (TDCs) of differing sizes.

3.8 Scenario 8: Change in new build programme

The inventory for disposal specified in the 2014 Implementing Geological Disposal White Paper [2] includes (paragraph 2.17)

> *Spent fuel (yet to be declared waste) and ILW from a new build programme up to a defined amount (see paragraphs 7.39 – 7.41)*

Paragraph 7.41 of the White Paper states that

> *With specific regard to waste from the UK's new build programme, the inventory for disposal will include a defined amount of spent fuel and ILW from a new nuclear build programme to be covered by the GDF siting process that any interested community will begin engaging with. This is in order to provide communities considering hosting a GDF as complete a picture as possible of the waste planned for a GDF in their local area, to allow them to take a fully informed decision on whether to host a facility. The current stated industry ambition for new nuclear development is 16 gigawatt electrical. This is not a Government target and the UK Government is supportive of industry bringing forward plans for further development in future. In that event, the UK Government would need to discuss and agree the disposal of this additional spent fuel and ILW with any communities participating in the GDF siting process, with a view to either expanding any existing facility development or seeking alternative facilities.*

In the absence of published inventory data for the UK ABWR, the 2013 Derived Inventory assumed that a 16 GW(e) new build programme would be composed of six UK EPRs and six AP1000s. However, the proposed composition of the new build programme is:

- EDF is proposing to build two UK European Pressurised Reactors (EPRs) at Hinkley Point in Somerset, followed by two UK EPRs at Sizewell in Suffolk, with 6.4 GW(e) total capacity.
- NuGen is proposing to build three AP1000 reactors at Sellafield in Cumbria with 3.4 GW(e) capacity.
- Horizon Nuclear Power is proposing to build two UK Advanced Boiling Water Reactors (ABWRs) at Wylfa in Anglesey and at Oldbury in South Gloucestershire with at least 5.4 GW(e) total capacity. The possibility of a third reactor at either of the sites has not been ruled out.

It is noted that in addition to the sites discussed above, Government's National Policy Statement for Nuclear Power Generation (2011) [17] identified three other potentially suitable sites for the deployment of new nuclear power stations in England and Wales before the end of 2025: Bradwell, Heysham and Hartlepool. EDF and China General Nuclear Power Corporation have signed the Heads of Terms of an agreement in principle to develop Bradwell B in Essex to a final investment decision with a view to building and operating the UK Hualong reactor technology.

In order to allow the impact of an alternative new build programme to be assessed (ie a programme of a different size or composition), this scenario is studied semi-quantitatively: inventory information is presented on a 'per reactor' basis for the AP1000, UK EPR and UK ABWR (ILW package numbers only). The data for the UK EPR and AP1000 might allow a reasonable approximation to be made for other pressurised water reactors (such as the Hualong PWR). However, the data will not be appropriate to other reactor types, particularly those with closed fuel cycles. Detailed information for other reactors, such as the Hualong PWR and one or more designs of small modular reactors, may need to be considered in due course.

3.8.1 Assumptions

The new build reactors are assumed to operate for 60 years and activity data are presented at 50 years after reactor shutdown. The inventory information is based on:

- GDA disposability assessment reports [18, 19] for the AP1000
- GDA disposability assessment reports [20, 21] and the PCSRs [22, 23] for the UK EPR
- the PCSR for the UK ABWR [24] (contains ILW package numbers only)

Where the GDA disposability assessment reports have not provided information on materials composition, materials have been assigned based on comparison with similar Sizewell B wastes.

The data that are presented here are appropriate for exploring moderate changes in the new build programme, such as the numbers of each type of LWR. It is not appropriate to use the data in this report to estimate the impact of major changes in the size of a new build programme as this would be likely to involve advanced reactors, with both open and closed fuel cycles as a possibility.

3.8.2 UK EPR

Volumes, package numbers

Table 13 presents numbers of waste packages and packaged volume of ILW and spent fuel for a UK EPR reactor.

Table 13 The number of packages and the packaged volume of waste groups for a UK EPR reactor

Waste group	Number of packages	Packaged volume (m^3)
New build UILW	71	232
New build SILW	1,690	3,150
New build SF	870	3,840

Activities

Table 14 presents the total activity and the activities of the priority 1 radionuclides for each waste group for a UK EPR reactor at 50 years after reactor shutdown.

Table 14 The total activity and the activities of the priority 1 radionuclides in the different waste groups for a UK EPR reactor at 50 years after shutdown

Radio-nuclide	Activity (TBq)		
	NB UILW	NB SILW	NB SF
Total activity	182,000	44.9	6,650,000
C14	921	0.914	203
Cl36	$8.39\ 10^{-2}$	$2.56\ 10^{-4}$	10.21
Co60	1,550	0.316	4.77
Se79	$5.86\ 10^{-2}$	$2.76\ 10^{-4}$	5.71
Kr85	2.36	$8.78\ 10^{-4}$	7,220

Radio-nuclide	Activity (TBq)		
	NB UILW	NB SILW	NB SF
Tc99	4.11	$2.61\ 10^{-3}$	1,230
I129	$6.88\ 10^{-5}$	$1.45\ 10^{-5}$	3.14
Cs135	$9.68\ 10^{-4}$	$6.77\ 10^{-5}$	47.1
Cs137	21.2	2.43	1,750,000
U233	$8.12\ 10^{-3}$	$3.02\ 10^{-6}$	$1.75\ 10^{-2}$
U235	$5.18\ 10^{-7}$	$2.65\ 10^{-7}$	0.684
U238	$1.86\ 10^{-7}$	$6.52\ 10^{-6}$	15.4
Np237	$4.63\ 10^{-5}$	$1.72\ 10^{-5}$	44.5

Material component data

Three sets of data are presented for the UK EPR reactor:

- data for materials in the waste are presented in Table B13
- data for conditioning and capping materials are presented in Table B14
- data for materials in the waste containers are presented in Table B15

The data are presented for each waste group for an UK EPR reactor.

3.8.3 AP1000

Volumes, package numbers

Table 15 presents the numbers of waste packages and packaged volume of ILW and spent fuel for an AP1000 reactor.

Table 15 The number of packages and the packaged volume of waste groups for an AP1000 reactor

Waste group	Number of packages	Packaged volume (m^3)
New build UILW	1,300	3,450
New build SF	620	2,730

Activities

Table 16 presents the total activity and the activities of the priority 1 radionuclides for each waste group for an AP1000 reactor at 50 years after reactor shutdown.

Table 16 The total activity and the activities of the priority 1 radionuclides in the different waste groups for an AP1000 reactor at 50 years after shutdown

Radio-nuclide	Activity (TBq)	
	NB UILW	NB SF
Total activity	31,800	4,660,000
C14	199	158

Radio-nuclide	Activity (TBq)	
	NB UILW	NB SF
Cl36	$1.92\ 10^{-2}$	1.74
Co60	105	62.8
Se79	$1.27\ 10^{-2}$	4.55
Kr85	0.449	4,960
Tc99	1.24	922
I129	$2.74\ 10^{-2}$	2.08
Cs135	$1.67\ 10^{-3}$	38.8
Cs137	50.0	1,230,000
U233	$1.10\ 10^{-2}$	$2.37\ 10^{-2}$
U235	$1.27\ 10^{-6}$	0.353
U238	$2.86\ 10^{-5}$	11.7
Np237	$5.90\ 10^{-5}$	30.5

Material component data

Three sets of data are presented for the AP1000 reactor:

- data for materials in the waste are presented in Table B16
- data for conditioning and capping materials are presented in Table B17
- data for materials in the waste containers are presented in Table B18

The data are presented for each waste group for an AP1000 reactor.

3.8.4 UK ABWR

At present the UK ABWR GDA disposability assessment has not been published. However, information on the anticipated numbers of packages that would be required is contained in the UK ABWR PCSR; these data are presented in Table 17. Data for spent fuel are not included.

Table 17 The numbers of packages associated with the UK ABWR ILW

Waste container	No. packages	Packaged volume (m^3)
New build UILW[9]	678	1,870
New build SILW (4 m box)	39	780

3.8.5 Packaging of new build Spent Fuel

New build spent fuel from AP1000 and UK EPR reactors is assumed to have a burn-up of 65 GWd/tU, and three spent fuel assemblies are accommodated in a disposal container. In the Hinkley Point C PCSR data are also given for a different UK EPR operating cycle with a burn-up of 50 GWd/tU. This would result in an increase in the number of fuel assemblies, but as the spent fuel assemblies have a lower burn-up, four could be accommodated in a

[9] It has been assumed that the variant of the 3 m^3 box with the round corners has been used.

disposal container and there would be a decrease of ~3% in the number of disposal containers.

3.8.6 Other reactor types

The implications of a range of potential new build reactors, including modular reactors has been studied previously [25]. This work also presents a high level description of the inventories that might be associated with the reactors considered.

3.9 Scenario 9: Inclusion of foreign wastes and materials

The 2013 Derived Inventory does not include any foreign wastes and materials. UK Government general policy is that radioactive waste should not be imported to or exported from the UK except in specifically defined and limited circumstances [9]. Import of radioactive waste into the UK might only be allowable where:

- spent sealed sources, originally manufactured in the UK, are being returned to the UK for treatment and disposal;
- the waste is from small users such as hospitals in either another EU Member State or a developing country where it would be impractical for them to acquire suitable disposal facilities; or
- there are reusable materials that can be extracted from the wastes, or materials are being treated to make them more manageable. Where the wastes generated as part of these processes would not add materially to the UK's existing wastes, it may be decided that it would be impractical to return the materials to the country of origin. In these circumstances, waste materials could be added to the UK stocks and, if an agreement to do so exists, a radiologically equivalent (or substitute) waste material would be returned instead.

No new waste types would be introduced to the inventory for disposal. For this reason, and because the impact on the inventory for disposal is anticipated to be small, this scenario is not studied quantitatively.

3.10 Scenario 10: Alternative packaging assumptions

Alternative packaging assumptions for wastes, including the use of new or alternative packages would affect the 2013 Derived Inventory packaged volume and the numbers of waste packages. However, it is difficult to quantify this scenario over and above the uncertainty that is presented in scenario 4.

Section 3.10.1 presents the status of waste packaging at the end of March 2014 while Section 3.10.2 discusses a number of alternative packaging options that might be feasible. The impact of these options on the inventory for disposal is discussed.

3.10.1 Disposability assessment process for waste packaging

The status of the ILW disposability assessments at the end of March 2014 is illustrated in Figure 8[10] [26], which shows the fraction of the ILW (by conditioned volume) that:

- has completed the disposability assessment process and therefore has a final Letter of Compliance (LoC) (13%, comprised of 5% that has already been packaged and 8% that is awaiting packaging)
- is in the process but does not yet have a final LoC (41%)
- has not yet begun the process (46%)

Details of which wastes have a final LoC (and wastes which have conceptual and interim stage LoCs) can be found in Section 8 of reference [26], which also identifies the packaging plants that are currently operational. For those wastes that do not yet have a final LoC, the waste packages specified by the waste producers are subject to change.

HLW in the 2013 Derived Inventory arises from the reprocessing of Magnox and AGR spent fuel. The HLW is currently being conditioned as a vitrified glass product and is stored in waste vitrification plant canisters. It is currently anticipated that three of these waste vitrification plant canisters will be packaged in a disposal container. The 2013 Derived Inventory reports 1,100 m^3 of HLW that is currently conditioned. This volume of conditioned waste represents approximately 78% of the total reported HLW in the 2013 Derived Inventory (however, this does not take account of waste substitution arrangements[11]).

In addition to existing wastes, there are some radioactive materials that are not currently classified as waste but would, if it were decided at some point that they had no further use, need to be managed through geological disposal. These include spent fuel (including spent fuel from new nuclear power stations), plutonium and uranium.

It is intended that all of the Magnox and 5,000 tU of AGR spent fuel will be reprocessed. The remaining AGR spent fuel will be packaged in disposal containers. The current policy is that the LWR spent fuel from Sizewell B (and any potential new build reactors) will not be reprocessed; this fuel is assumed to be disposed of in its current form. Further discussion of alternative reprocessing scenarios is covered in Sections 3.1 and 3.2. The disposal of plutonium and uranium is discussed in Sections 3.5 and 3.7).

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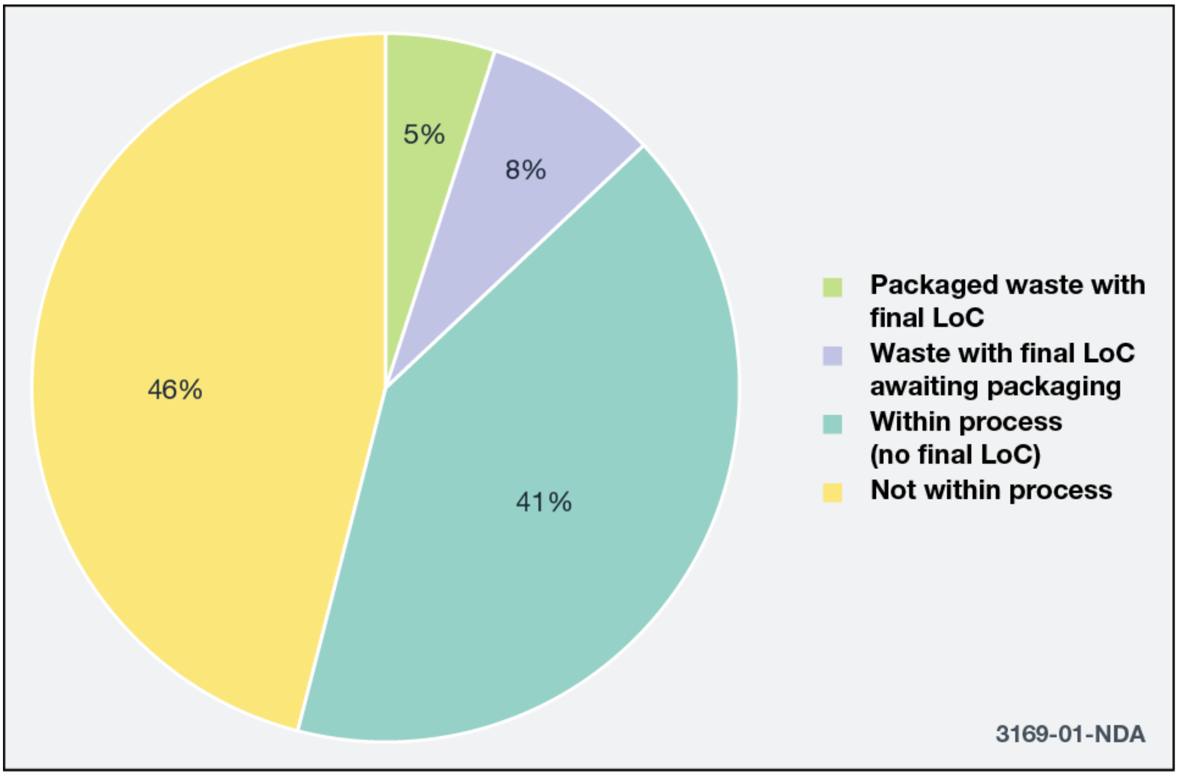
10 Data complete to March 2013; volumes based on the 2010 UK RWI.

11 Reprocessing of irradiated nuclear fuel separates uranium and plutonium and creates LLW, ILW and HLW. The UK reprocesses some fuel from other countries under commercial reprocessing agreements. All reprocessing contracts signed since 1976 include an option for the UK to return the waste arising from reprocessing to the country of origin and in 1986 the Government decided that these waste return options should be applied. ‘Substitution’ is a concept where the UK retains the higher volume of LLW and ILW for long term management in this country but returns a greater amount of HLW to the customer. This substituted waste is carefully calculated to be equivalent in radiological terms.

Figure 8 **The fraction of ILW (by conditioned volume) that has a final LoC and is in the disposability assessment process (data complete to March 2013; volumes based on the 2010 UK RWI)**



3.10.2 Analysis of uncertainty in future waste management practices

The 2013 UK RWI estimates of waste conditioning and packaging factors are based on current waste treatment and packaging plans continuing until the end of site operations. However, revised strategies may be developed, and new treatments may be introduced that reduce volumes and numbers of waste packages. Also packaging schemes are still under development for many wastes, particularly decommissioning wastes, and so there are greater uncertainties in their volumes.

Thermal treatment of ILW

The thermal treatment of radioactive wastes is under development as an alternative to established processing techniques. Thermal treatment offers a number of advantages, including:

- the destruction of organic species, thus reducing the potential for deleterious effects on the geological disposal system's chemical barrier
- a reduction in waste volume, leading to fewer waste packages in which voidage is largely eliminated

However, it is not without consequences, including the need to manage off-gases and deal with the production of secondary wastes.

Thermal treatment processes are a potentially viable solution for some wastes. It is recognised that the product matrix of these processes can range from glass to ceramic to metals, and the waste cannot always be described as 'vitrified'.

In order to assess the potential impact on the inventory for disposal, RWM has assumed that the following wastes may be suitable for thermal treatment[12]:

- alpha contaminated material
- pond sludge
- spent ion exchange wastes
- contaminated soil

In addition, the declared waste package type is assumed to be retained (though alternative containers might be proposed) and the small volume of secondary wastes that would be produced is neglected[13]. Two different volume reductions arising from thermal treatment have been considered and the results are discussed below:

- thermal treatment results in a three-fold reduction in the volume of waste: this could result in a significant reduction in the quantity of waste (of the order of ten thousand disposal units and a packaged volume of around a few tens of thousands of cubic metres); and
- thermal treatment results in no volume reduction of the waste: this could result in a small reduction in quantity of waste (as conditioning materials such as grout are not required) and a corresponding reduction in the number of disposal units. The magnitude of the changes would be a packaged volume of around a few thousand cubic metres and around one thousand disposal units.

Use of robust shielded containers (RSCs)

In the 2013 UK RWI Magnox Limited has implemented wide use of RSCs as a waste container at all of its reactor sites except Hunterston A and Trawsfynydd. RSCs are also reported as the waste container for resins at the Sizewell B PWR.

In order to assess the implications of more widespread usage of RSCs, RWM has assumed that the following could be packaged in RSCs[14]:

- EDF ILW, excluding Stage 3 decommissioning wastes, those waste planned to be stored until Stage 3 decommissioning and waste currently planned for disposal to LLWR
- GE Healthcare ILW not destined for incineration or disposal to LLWR

It is further assumed that these wastes are packaged in 500 l robust shielded drums[15] with 20 mm of lead shielding.

Based on the assumptions detailed above, there would be the following impacts on the inventory for disposal:

- a reduction in the number of UILW waste packages (500 l drums and 3 m^3 boxes)

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12 It is noted that in making these assumptions RWM has not assessed the use of thermal treatment for these wastes. It is further noted that the thermal treatment of these wastes has not yet been demonstrated on an industrial scale.

13 The parameters being explored here are the number of packages, the packaged volume and the activity. It is not anticipated that these wastes will have a significant impact on any of these parameters and it is acknowledged that there will be different challenges associated with their disposability.

14 It is noted that in making these assumptions, RWM has not assessed the disposability of the wastes or the requirement for additional lead shielding. The assumptions have been made to allow indicative calculations to be carried out.

15 Use of the RS drums has been assumed instead of the RS boxes since they have a lower packaging efficiency.

- an overall increase in the number of disposal units (of the order of 1,000)
- an increase in the packaged volume of the waste (of the order of 1,000 m^3)
- an increase in the quantity of lead in the inventory for disposal (of the order of 1,000 t)

HLW and SF

HLW and spent fuel disposal container designs include two variants [27]:

- Variant 1 is a long-lived disposal container (~100,000+ years) based on the SKB KBS-3 disposal container concept
- Variant 2 is a shorter-term container (~10,000 years) based on the NAGRA disposal container concept

The 2013 Derived Inventory assumes use of the Variant 1 copper disposal containers for HLW and spent fuel. A change to the Variant 2 disposal container design would result in small changes to the packaged volume (of around a few percent) as a result of slight differences in the designs; there would be no change in the number of disposal containers.

Whereas the Variant 1 disposal container is composed of a copper outer shell that has a cast iron insert, the Variant 2 disposal container is composed of a carbon steel outer shell with a ‘basket’ to hold its contents. As a result, the Variant 2 disposal container is lighter than the Variant 1 disposal container. The exact reduction depends on the material that the disposal container is designed for and is in the range of approximately 25% - 35%.

It is possible that the PWR spent fuel could be disposed of with additional components (the rod cluster control assemblies) that might otherwise be disposed of as ILW. This would require a redesigned disposal container that is approximately 200 mm (5%) longer and there would be an associated increase in the mass of the container.

Multipurpose Containers

An option being considered by NDA for the management of spent fuel and HLW involves the use of multi-purpose containers (MPCs) [28]. MPCs are containers that are designed to meet the requirements for the safe containment of radioactive waste during storage, transport and disposal. Most of the MPCs that have been designed have been developed for storage and transport of spent fuel overseas. These have been designed to maximise loading in order to minimise the number of package movements and storage areas. There are two methods of containing spent fuel considered:

- spent fuel is placed in a sealed vessel that is contained in a different overpack for storage, transport and disposal
- spent fuel is placed in a single container that meets the safety requirements of all phases of waste management (storage, transport and disposal)

Examples of each type of containment are described in a feasibility study on using MPCs for the disposal of SF and HLW [28]; this report also provides details of specific MPC designs for PWR spent fuel assemblies. The maximum MPC capacity is dictated by the need to ensure that the overall dimensions and mass of the MPC in its transport configuration meet the requirements for UK rail transport. The maximum capacity is 12 PWR fuel assemblies and this would result in a threefold reduction in the number of packages. MPC variants have also been considered for HLW and AGR spent fuel.

3.11 Scenario 11: Exclusion of Graphite wastes

The NDA's work [29] has demonstrated that the management of graphite waste by geological disposal provides a robust baseline strategy suitable for planning purposes. In the case of reactor decommissioning graphite, which is the bulk of the graphite inventory, there will be time to develop and assess alternative strategies during the extended period of reactor quiescence. NDA has identified factors that would drive a review of the baseline strategy and will ensure that these are considered in future decisions on the management of graphite waste.

This section shows the impact on the inventory for disposal of an alternative disposal route for graphite.

3.11.1 Assumptions

Those waste streams considered to be graphite are:

- final stage clearance graphite streams
- 2S302: Windscale piles graphite (UILW)
- 2F07: AGR graphite fuel assembly components (UILW)
- 5C302: BEPO graphite (SILW)

Table 18 presents all of the graphite waste streams and their waste categories.

Table 18 Graphite waste streams not disposed of to the GDF

ID	Waste stream name	Waste category
2A303	Final Dismantling & Site Clearance: Graphite LLW	SLLW
2A310	Final Dismantling & Site Clearance: Graphite ILW	UILW
2F07	AGR Graphite Fuel Assembly Components	UILW
2S302	Windscale Pile1 and Pile 2 Graphite and Aluminium Charge Pans	UILW
3J313	Decommissioning Stage 3: Graphite ILW	SILW
3J317	Decommissioning Stage 3: Graphite LLW	SLLW
3K313	Decommissioning Stage 3: Graphite ILW	SILW
3K317	Decommissioning Stage 3: Graphite LLW	SLLW
3L313	Decommissioning Stage 3: Graphite ILW	SILW
3L317	Decommissioning Stage 3: Graphite LLW	SLLW
3M313	Decommissioning Stage 3: Graphite ILW	SILW
3M317	Decommissioning Stage 3: Graphite LLW	SLLW
3N313	Decommissioning Stage 3: Graphite ILW	SILW
3N317	Decommissioning Stage 3: Graphite LLW	SLLW
5C302	BEPO Research Reactor ILW	SILW
9A316	Graphite LLW	SLLW

ID	Waste stream name	Waste category
9A321	Graphite ILW	SILW
9B312	Graphite ILW	SILW
9B316	Graphite LLW	SLLW
9C312	Graphite ILW	SILW
9D312	Graphite ILW	SILW
9D316	Graphite LLW	SLLW
9E315	Final Dismantling & Site Clearance: Graphite LLW	SLLW
9E319	Final Dismantling & Site Clearance: Graphite ILW	SILW
9F312	Graphite ILW	SILW
9G311	Final Dismantling & Site Clearance: Graphite ILW	SILW
9G316	Final Dismantling & Site Clearance: Graphite LLW	SLLW
9H311	Final Dismantling & Site Clearance: Graphite ILW	SILW
9H315	Final Dismantling & Site Clearance: Graphite LLW	SLLW

3.11.2 Volumes and package numbers

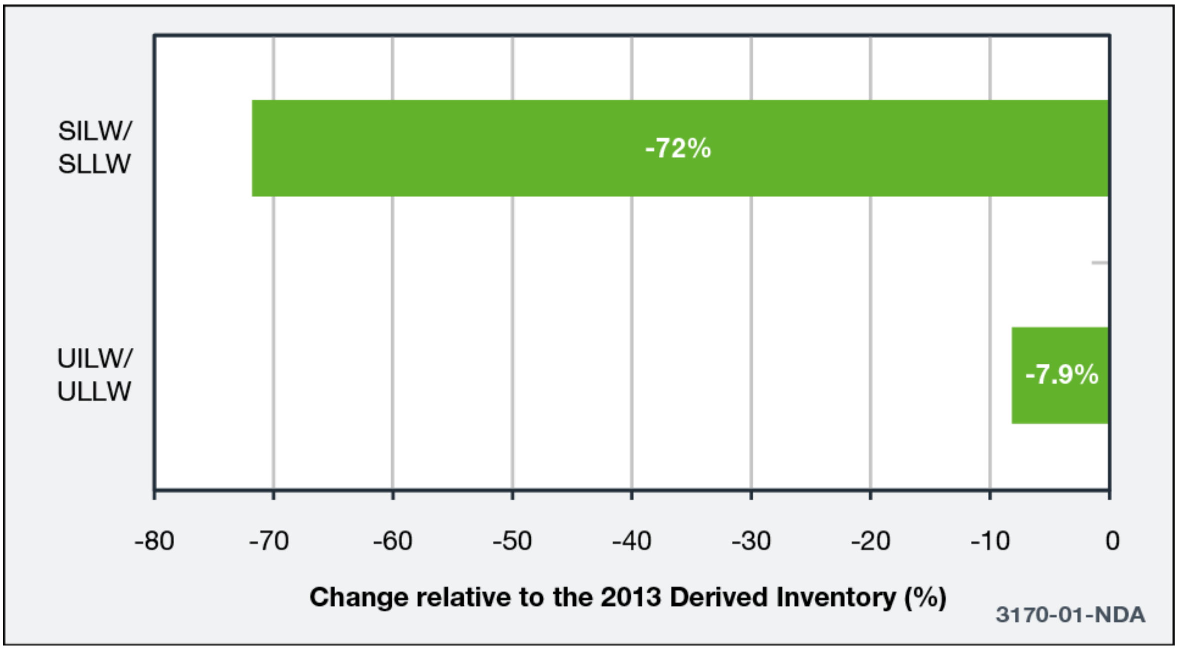
The impact of graphite wastes not being disposed of to the GDF on the numbers of packages and packaged volumes is indicated in Table 19. The overall packaged volume has decreased by 92,900 m^3 and the number of packages has decreased by 26,100. This is equivalent to a decrease of ~12% in the total packaged volume and a decrease of 9.6% in the total number of waste packages compared to the 2013 Derived Inventory values. There is a significant reduction in SILW / SLLW, with a smaller reduction in UILW / ULLW.

Figure 9 illustrates the percentage change in packaged volume for the waste groups affected by scenario 11. The SILW / SLLW waste group is significantly reduced because the Magnox and AGR final stage clearance graphite is packaged in SILW containers and these form the bulk of the SILW / SLLW inventory. The reduction in the UILW / ULLW is more modest.

Table 19 The number of packages and the packaged volume for those waste groups affected by this scenario

Waste group	Number of packages		Packaged volume (m^3)	
	2013 DI	Scenario 11	2013 DI	Scenario 11
UILW / ULLW	197,000	174,000	327,000	301,000
SILW / SLLW	4,850	1,440	93,000	25,700
Total	202,000	176,000	420,000	327,000

Figure 9 The percentage change in packaged volume for those waste groups affected by this scenario



3.11.3 Activities

The total activity associated with the 2013 Derived Inventory is 27,300,000 TBq. The exclusion of the graphite wastes leads to a reduction of ~7,160 TBq in the total activity.

Table 20 presents the activities of the priority 1 radionuclides at 2200 for the 2013 Derived Inventory and this scenario; the percentage change is also shown. The total C14 activity has decreased by 6,920 TBq (~40%) and the total Cl36 activity has decreased by 27.1 TBq (~25%) compared with the total 2013 Derived Inventory activities.

Table 20 The activities of the priority 1 radionuclides at 2200 for all waste groups

Radio-nuclide	2013 DI	Scenario 11	Change (%)
C14	17,600	10,600	-40%
Cl36	114	87.0	-25%
Co60	2.12	2.12	< -1%
Se79	96.8	96.8	< -1%
Kr85	1,250	1,250	< -1%
Tc99	19,100	19,100	< -1%
I129	42.1	42.1	< -1%
Cs135	919	919	< -1%
Cs137	5,040,000	5,040,000	< -1%
U233	2.51	2.45	-2%
U235	53.8	53.8	< -1%
U238	2,560	2,560	< -1%
Np237	837	837	< -1%

Table B37 presents the activities of the priority 1 radionuclides at 2200 by waste group; information is only presented for those waste groups that have changed.

3.11.4 Material component data

Three sets of data are presented for this scenario:

- data for materials in the waste are presented in Table B19
- data for conditioning and capping materials are presented in Table B20
- data for materials in the waste containers are presented in Table B21

Overall the waste material mass has decreased by 75,100 t, the conditioning and capping material mass has decreased by 48,100 t and the waste container mass has decreased by 35,300 t.

3.12 Scenario 12: Exclusion of ILW / LLW boundary wastes

Boundary wastes were defined by the LLWR [30] as ILW and LLW with a concentration of specific radionuclides that prohibits or significantly challenges its acceptability at existing and planned future disposal facilities for LLW, but that could be practicably managed as LLW (on the basis of radiochemical and physiochemical properties) through application of some treatment process or decay storage.

The 2013 UK RWI includes 42 ILW streams that waste producers expect to manage as LLW through near-surface disposal by using radioactive decay storage and / or decontamination processes. Some combustible wastes are expected to be incinerated and some metal wastes are expected to be recycled.

Only those ILW streams where there is an established decontamination or incineration process were excluded from the 2013 Derived Inventory. All other ILW streams expected to be managed as LLW were included.

The impact of removing these streams from the 2013 Derived Inventory would be a reduction in ILW for disposal to the GDF, and has been studied quantitatively.

3.12.1 Assumptions

Table 21 presents packaged volumes, and the numbers of waste packages for those ILW streams in the 2013 Derived Inventory that waste producers expect to manage through a disposal route other than the GDF. The effect on the Derived Inventory of removing these waste streams is studied in this scenario.

Table 21 2013 Derived Inventory ILW streams intended to be managed as LLW

Waste stream ID	Waste stream name	Waste group	Packaged volume (m^3)	Number of waste packages [16]
1A08	Decay Stored Waste	UILW	32.6	10
2D42	Magnox Pond Furniture	UILW	3,690	1,130
2F15	LWR Pond Furniture (MEBs)	UILW	2,300	702
3J04	Desiccants ILW	UILW	190	73
3J20	Catalysts ILW	UILW	5.80	3
3J25	Gag Pistons	UILW	19.1	34
3K04	Desiccant	UILW	235	90
3K22	Catalyst	UILW	10.4	4
3K29	Bypass Blowdown Filters	UILW	36.9	12
3L04	Desiccant	UILW	131	51
3L19	Catalyst	UILW	9.20	4
3L24	Bypass Blowdown Filters	UILW	56.1	18
3M04	Desiccant	UILW	122	47

[16] The numbers of waste packages are rounded up to the nearest whole number of waste packages.

Waste stream ID	Waste stream name	Waste group	Packaged volume (m^3)	Number of waste packages [16]
3M17	Catalysts	UILW	24.7	10
3N04	Desiccants and Catalysts	UILW	416	160
7D24	ILW Reactor Components	SILW	16.1	1
7D29	Intermediate Level Waste Resin from Plant Decontamination (MODIX)	UILW	47.6	84
7D40	ILW PCD Ion Exchange Resin	UILW	33.4	13
7D41	ILW Submarine Ion Exchange Resin	UILW	60.0	23
7E27	Submarine Ion Exchange Resin	UILW	11.6	5
7E29	Intermediate Level Ion Exchange Resin (Decontamination)	UILW	96.9	38
7V24	Metallic ILW from Vulcan	UILW	146	45
7V25	Resin from Decontamination Operations	UILW	7.00	13
9A18	Desiccant	SILW	57.2	11
9B13	Desiccant	SILW	2.20	1
9B13/C	Desiccant	SILW	61.1	12
9C14	Desiccant	SILW	52.1	10
9C44	Fuel Skips in Pond	UILW	192	59
9C45	Fuel Skips in Pond	UILW	169	52
9C63	AETP Sludge	SILW	72.9	14
9D18	Desiccant	SILW	36.7	7
9E47	Desiccant	SILW	34.4	7
9E61	Fuel Skips in Pond	UILW	72.3	23
9F14	Desiccant and Catalyst from Gas Conditioning Plant	SILW	11.5	3
9F18	Miscellaneous Drummed Contaminated and Activated Items	SILW	111	6
9F39	Fuel Skips in Pond	UILW	256	79
9F42	AETP Filters - Sand and Gravel	SILW	40.9	8
9G113	CDVAR Plates	SILW	16.6	1
9H02	Desiccant	SILW	122	23

3.12.2 Volumes and package numbers

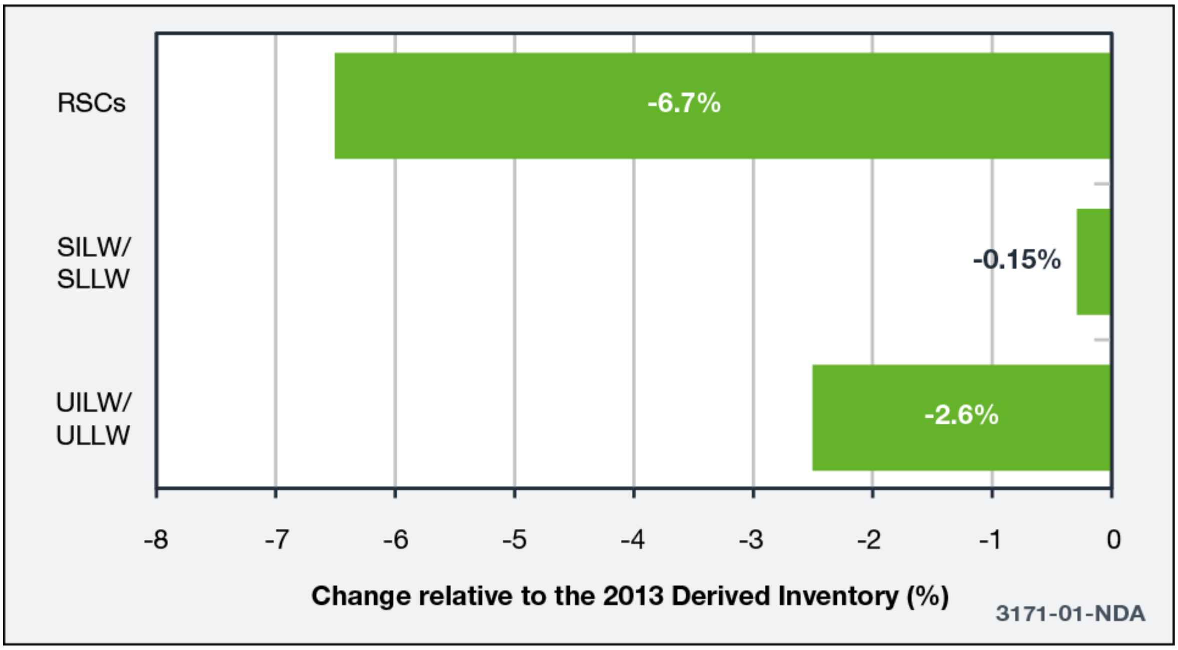
The impact of the removal of ILW that waste producers expect to dispose of as LLW on the numbers of packages and packaged volumes is indicated in Table 22. The packaged volume has decreased by 9,000 m^3 and the number of packages has decreased by 2,860. These changes represent decreases of less than 1.2% and 1% respectively in the overall 2013 Derived Inventory values.

Table 22 The number of packages and the packaged volume for those waste groups affected by this scenario

Waste group	Number of packages		Packaged volume (m^3)	
	2013 DI	Scenario 12	2013 DI	Scenario 12
UILW / ULLW	197,000	194,000	327,000	318,000
SILW / SLLW	4,850	4,850	93,000	92,800
RSCs	2,270	2,180	7,280	6,790
Total	204,000	201,000	427,000	418,000

Figure 10 illustrates the percentage change in packaged volume for the waste groups affected by scenario 12. The impact of the scenario is largest for RSCs.

Figure 10 The percentage change in packaged volume for those waste groups affected by this scenario



3.12.3 Activities

In this scenario there is a reduction of ~1,410 TBq in the total activity of the Derived Inventory. The reason that the change is small is that the waste streams that have been removed have relatively low specific activities.

Table 23 presents the activities of the priority 1 radionuclides at 2200 for all waste groups for the 2013 Derived Inventory and this scenario, the percentage change is also presented. It can be seen that none of the priority 1 radionuclides are significantly affected.

Table 23 The activities of the priority 1 radionuclides at 2200 for all waste groups

Radio-nuclide	2013 DI	Scenario 12	Change (%)
C14	17,600	17,500	< -1%
Cl36	114	114	< -1%
Co60	2.12	2.12	< -1%
Se79	96.8	96.8	< -1%
Kr85	1,250	1,250	0
Tc99	19,100	19,100	< -1%
I129	42.1	42.1	< -1%
Cs135	919	919	< -1%
Cs137	5,040,000	5,040,000	< -1%
U233	2.51	2.51	< -1%
U235	53.8	53.8	< -1%
U238	2,560	2,560	< -1%
Np237	837	837	< -1%

Table B38 presents the activities of the priority 1 radionuclides at 2200 by waste group; information is only presented for those waste groups that have changed.

3.12.4 Material component data

Three sets of data are presented for this scenario:

- data for materials in the waste are presented in Table B22
- data for conditioning and capping materials are presented in Table B23
- data for materials in the waste containers are presented in Table B24

Overall the waste material mass has decreased by 6,430 t, the conditioning and capping material mass has decreased by 3,950 t and the waste container mass has decreased by 3,510 t.

4 Summary of results of scenario analysis

This report has explored

- the uncertainties in the data in the 2013 Derived Inventory
- possible changes to the assumptions in the 2013 Derived Inventory

This has been done through considering a number of different scenarios. Scenarios have been chosen that highlight key changes to the waste quantities, waste characteristics or assumptions. The results presented in this report will allow RWM to assess the implications of the alternative inventory scenarios on its designs and safety cases.

Twelve scenarios have been presented and each of these is discussed in one of four ways:

- fully quantitatively (scenarios 2, 3, 4 a – d, 11 and 12)
- semi-quantitatively (scenario 10)
- by providing some quantitative information that could be used to study the scenario in the future (scenarios 7 and 8, which provide inventory information for a unit quantity)
- qualitatively (scenarios 1, 5, 6 and 9)

The results of the scenarios are summarised for each of these four groups.

4.1 Fully quantitative analysis

Scenario 2 (less reprocessing of Magnox fuel): the 2013 Derived Inventory assumes that all Magnox spent fuel is reprocessed. This scenario shows how the inventory would be impacted if 3,000 tU of Magnox spent fuel was not reprocessed:

- The impact on the activity would be negligible
- There would be an increase of around 1% in the packaged volume
- No new waste types would be introduced but as the Magnox fuel is metallic, there would be a significant increase in the quantity of metallic fuel in the inventory

Scenario 3 (Lifetime extensions for existing reactors): the 2013 Derived Inventory assumes that the operational reactors continue to operate for the remainder of their approved lifetimes. However, EDF has successfully applied for lifetime extensions for some of its reactors and is in the process of applying for life extensions for the remaining reactors. This scenario shows how the inventory would be impacted if the reactor lifetimes were extended:

- The activity of the inventory would increase by 4.5%
- There would be an increase of around 1% in the packaged volume
- No new waste types would be introduced

Scenario 4 (use of UK RWI uncertainty estimates): The 2013 Derived Inventory uses the best estimate data from the UK RWI. In addition to this, waste producers also specify an upper and lower uncertainty estimate on both the volume and activity of the wastes. This scenario shows how these uncertainties impact on the inventory:

- Based on the uncertainties in the activities, the total activity of the inventory could be up to 2.4% lower or up to 99% higher. The lower activity uncertainty value is dominated by HLW. The upper activity uncertainty value is dominated by a single waste stream, 3S306[17], with three others also making a significant contribution

[17] 'Sizewell B decommissioning stainless steel ILW'.

(3K30, 3N38 and 3L25)[18]. These waste streams have upper uncertainty factors of 100 or 1,000 on each radionuclide. These uncertainty factors bound the maximum activities and are not a realistic estimate of the possible maximum activities. Carrying out analysis to reduce the uncertainty in these waste streams such that the uncertainty factors give a realistic representation of the possible range of activities would significantly reduce the uncertainty in the 2013 Derived Inventory.

- Based on the uncertainties in the volumes of waste, the packaged volume of the inventory could be up to 14% lower or 49% higher. It was shown that reducing the uncertainty in two streams (2D116[19] and 2D137[20]) could significantly reduce the uncertainty in the waste volume. Arisings for these streams will not commence for several years and, as a result, minimal characterisation has been carried out at this stage.
- No new waste types would be introduced in this scenario.

Scenario 11 (exclusion of graphite wastes): the 2013 Derived Inventory assumes that graphite wastes will be disposed of to the GDF, which is the baseline strategy. In the case of reactor decommissioning graphite, which is the bulk of the graphite inventory, there will be time to develop and assess alternative strategies during the extended period of reactor quiescence. In this scenario, the implications of the exclusion of graphite wastes from the Derived Inventory are assessed:

- there would be negligible impact on the total activity, but the activity associated with C14 and Cl36 would be significantly reduced
- the packaged volume of the inventory would be reduced by 12%
- no new waste types would be added and there would a significant reduction in the graphite in the Derived Inventory

Scenario 12 (exclusion of ILW / LLW boundary wastes): The 2013 Derived Inventory includes ILW / LLW boundary wastes unless there is an established route for disposal as LLW. This scenario shows the impact of excluding these boundary wastes from the Derived Inventory:

- there would be negligible impact on the total activity
- there would be a small reduction (1.2%) in the packaged volume
- no new waste types would be introduced

The impact that each of the fully quantitative scenarios would have on the 2013 Derived Inventory is compared in Figure 11 and Figure 12.

Figure 11 illustrates the percentage change in the packaged volume for each of the scenarios relative to the 2013 Derived Inventory. The figure shows that three of the scenarios have a very small impact on the Derived Inventory: scenario 2 (reprocessing less Magnox fuel), scenario 3 (lifetime extensions for existing reactors) and scenario 12 (exclusion of ILW / LLW boundary wastes). Of the other scenarios, two entail reductions in the packaged volumes of around 12-14% (scenario 11: exclusion of graphite wastes, and scenario 4a: use of lower UK RWI uncertainty factors). The greatest impact is for scenario 4b (use of upper UK RWI uncertainty factors), where there is a volume increase of 49%.

Figure 12 illustrates the percentage change in activity for each of the scenarios relative to the 2013 Derived Inventory. The figure shows that all of the scenarios have a relatively small impact (<5%), with the exception of scenario 4d (use of UK RWI upper activity uncertainty factors). However, as noted in Section 3.4, the majority of this increase in

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[18] All ‘AGR station miscellaneous activated components and fuel stringer debris’.

[19] ‘Miscellaneous Plants Initial/Interim Decommissioning: Processing Plants, Tanks, Silos, etc’.

[20] ‘Miscellaneous Plants Final Decommissioning: Processing Plants, Tanks, Silos, etc’.

activity is associated with a single waste stream (3S306[17]), which has been assigned an upper uncertainty factor of 1,000 for each radionuclide present. Three other waste streams (3K30, 3N38 and 3L25)[18] also make significant contributions. Reducing the uncertainty in these waste streams would have a significant impact on the uncertainty in the Derived Inventory.

Two scenarios would significantly affect the types of waste in the inventory:

- Scenario 2 (reprocessing less Magnox fuel), which would significantly increase the quantity of metallic fuel in the inventory
- Scenario 11 (exclusion of graphite wastes), which would significantly reduce the quantity of graphite in the inventory

Figure 11 Changes in total packaged volume from 2013 Derived Inventory across scenarios

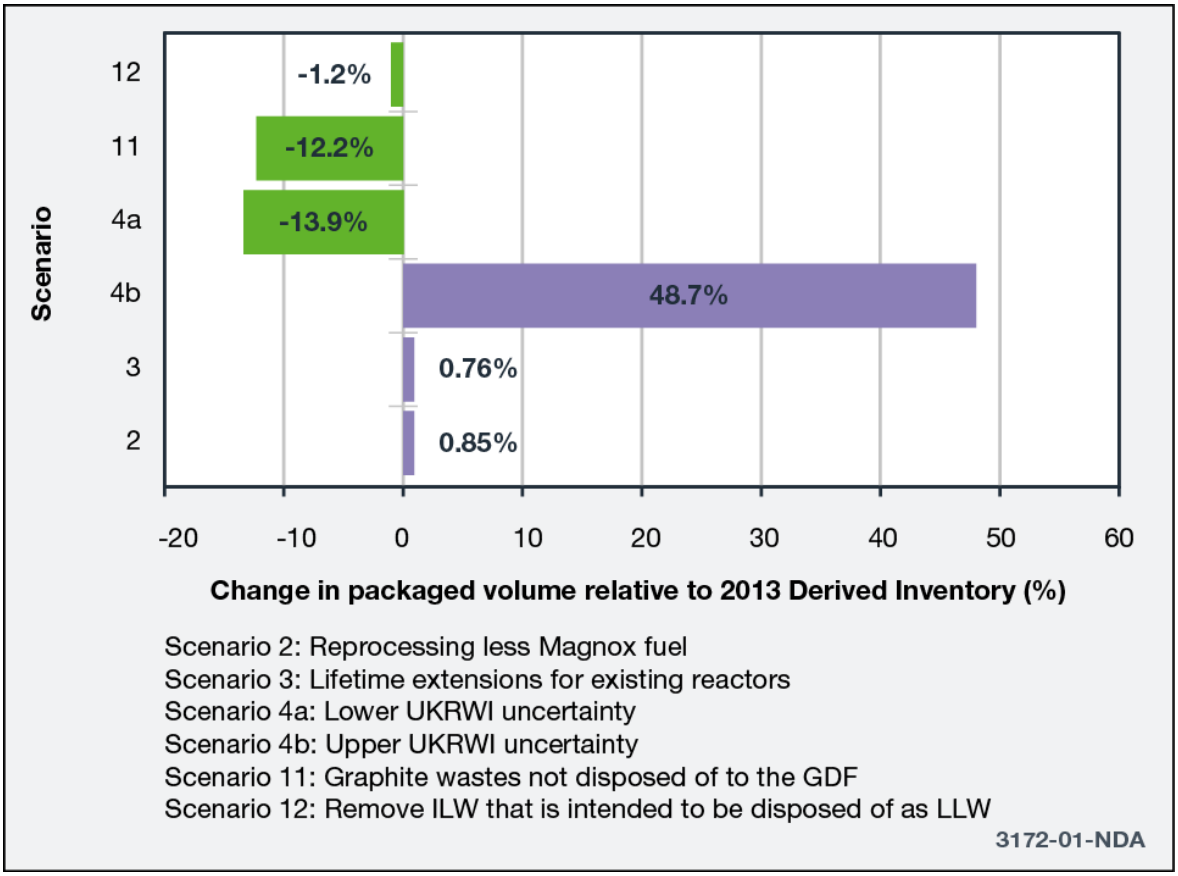
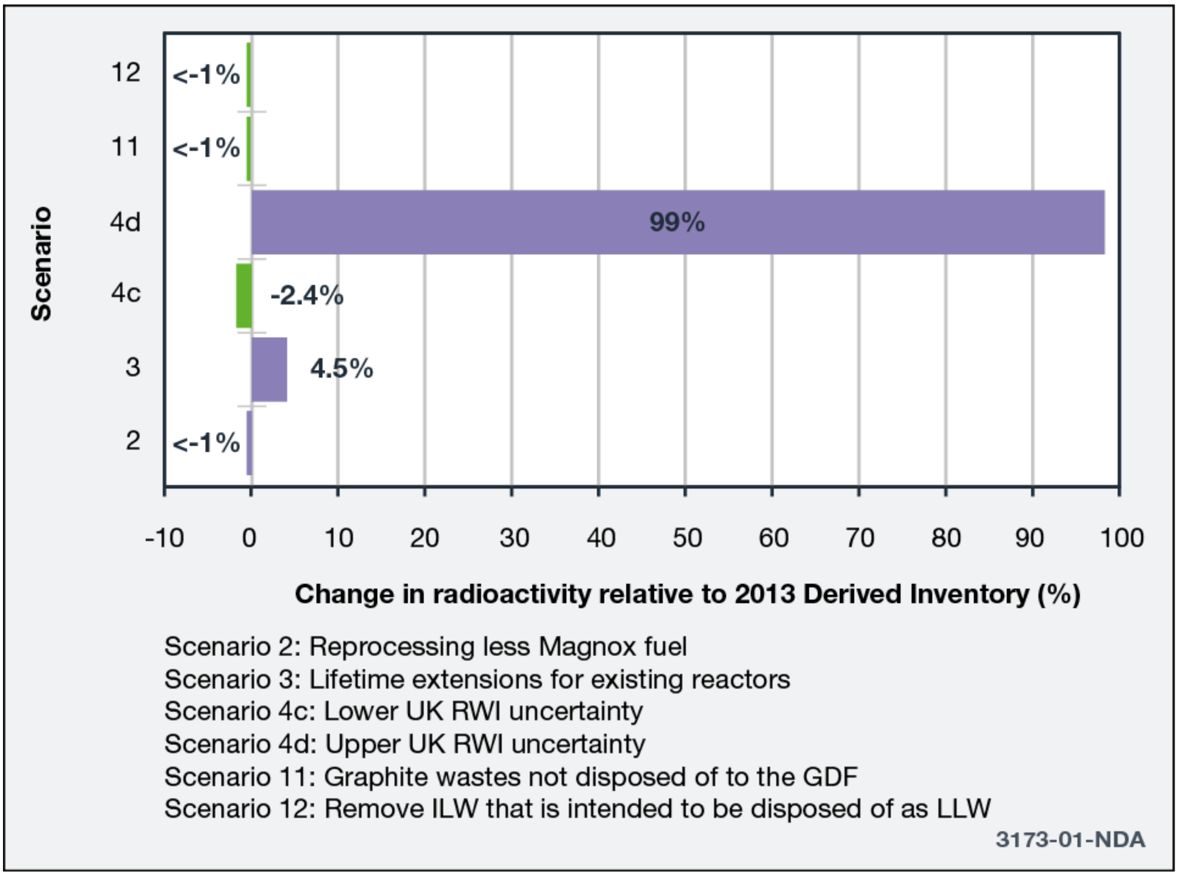


Figure 12 Changes in activity from 2013 Derived Inventory across scenarios



4.2 Semi-quantitative analysis

Scenario 10 (Alternative packaging assumptions) has been considered semi-quantitatively.

About half of all forecast ILW (by conditioned volume) has not yet started RWM's disposability assessment process. Packaging strategies are still under development for many wastes, particularly decommissioning wastes, and it is these wastes where there is the most uncertainty in the 2013 Derived Inventory packaging data and assumptions. Factors affecting packaged waste volumes and the numbers of disposal units include:

- changes in processing strategy (eg use of thermal treatment, metal recycling, size reduction)
- use of alternative containers or new container designs (eg RSCs)

Compared to the total 2013 Derived Inventory values it is estimated that:

- thermal treatment may result in decreases of up to ~5% in the packaged volume and ~8% in the number of disposal units
- the use of RSCs could result in small increases of less than 0.5% in the packaged volume and the number of packages

4.3 Inventory information for a unit amount

Scenarios 7 and 8 are considered semi-quantitatively using scoping calculations.

Scenario 7 is about the effects of a change in the mass of DNLEU on the 2013 Derived Inventory. The information provided is the number of waste packages, the packaged volume and the activity for one tonne of DNLEU.

Scenario 8 deals with changes to the new build programme. Inventory data are provided for one AP1000 and one UK EPR. The number of ILW packages for a UK ABWR is also given.

4.4 Qualitative analysis

Scenario 1 (Reprocessing more oxide fuel): the 2013 Derived Inventory assumes that 4,500 tU of AGR spent fuel is reprocessed and that the remainder, along with all spent fuel from Sizewell B and the spent fuel from a new build programme is not reprocessed. This scenario does not align with the decisions of NDA or EDF and is therefore considered to be a low likelihood. Changes to the assumptions on reprocessing in the 2013 Derived Inventory would not present any new challenges (the radionuclide inventory would not change significantly and no new waste types would be introduced).

Scenario 5 (Products of management of plutonium): the 2013 Derived Inventory assumes that the vast majority of the plutonium inventory will be reused in LWRs in the form of mixed oxide (MOX) fuel, and any remaining plutonium whose condition is such that it could not be converted into MOX would be immobilised and treated as waste for disposal. This is consistent with the UK Government's policy for the long-term management of plutonium. There are various re-use options and RWM will contribute to NDA's work on these through its disposability assessment process. The implications of immobilising all of the separated plutonium and treating it as waste were covered in the 2007 and 2010 Derived Inventories.

Scenario 6 (LLW from the LLWR is disposed of to the GDF): this scenario is unlikely to occur because LLWR Ltd has concluded that no intrusive remediation of the old LLWR trenches is warranted and the Environment Agency has not raised any specific objections to LLWR's proposal on this topic. In addition, if any LLW was removed from the LLWR, the changes in the activity and volume of wastes for disposal to the GDF would be within those quantified for scenario 4.

Scenario 9 (Inclusion of foreign wastes and materials): the 2013 Derived Inventory does not include any foreign wastes and materials. UK Government general policy is that radioactive waste should not be imported to or exported from the UK except in specifically defined and limited circumstances [9]. If any foreign wastes were imported for geological disposal, no new waste types would be involved and the impact on the Derived Inventory would be small.

5 Conclusions

This report has explored

- the uncertainties in the data in the 2013 Derived Inventory
- possible changes to the assumptions in the 2013 Derived Inventory

This has been done through considering a number of different scenarios. Scenarios have been chosen that highlight key changes to the waste quantities, waste characteristics or assumptions. The results presented in this report will allow RWM to assess the implications of the alternative inventory scenarios on its designs and safety cases.

In most of the scenarios that have been analysed quantitatively or semi-quantitatively, it has been shown that neither the total packaged volume of wastes in the Derived Inventory, nor the total activity, changes by more than 14%. The principal exceptions are the scenarios in which the upper activity uncertainty estimates and upper packaged volume uncertainty estimates in the UK RWI are used. In both cases the uncertainties are dominated by those for a few specific waste streams and are expected to be reduced by better characterisation.

For most of the scenarios that have been analysed qualitatively, the effects on the Derived Inventory are expected to be small.

RWM is contributing to NDA work for Government to support a future decision on the implementation of a strategy for the long-term management of separated plutonium. Information is presented in the report about the implications for the Derived Inventory of various potential strategies.

The report also contains information to assist in analysing the effects on the Derived Inventory of changes in the mass of DNLEU for disposal and changes in the UK new build programme.

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Glossary

A glossary of terms specific to the generic DSSC can be found in the Technical Background

Term	Definition
AGR	Advanced gas-cooled reactor
AP1000	Pressurised water reactor sold by Westinghouse Electric Company
BFS	Blast furnace slag
Conditioned volume	The conditioned waste volume is the volume of the wasteform (waste plus immobilising medium) within the container
DECC	Department of Energy and Climate Change. The responsibilities of DECC were transferred to the Department for Business, Energy and Industrial Strategy in July 2016
DNLEU	Depleted, natural & low-enriched uranium - comprises all types of uranium with the exception of HEU
DSSC	Disposal System Safety Case
DU	Depleted uranium
EPR	EPR is now used by AREVA as a reactor name, it was previously used to mean European Pressurized Reactor and Evolutionary Power Reactor;
GDA	Generic design assessment
GDF	Geological disposal facility
HEU	Highly enriched uranium
HHGW	High heat generating waste
HLW	High Level Waste
ILW	Intermediate Level Waste
IPT	Integrated project team
Legacy waste	Radioactive waste which already exists or whose arising is committed in future by the operation of an existing nuclear facility
LHGW	Low heat generating waste
LLW	Low Level Waste
LLWR	Low Level Waste Repository
LoC	Letter of Compliance
LWR	Light water reactor
MDU	Magnox depleted uranium
MEB	Multi element bottle

MOX	Mixed oxide
MPC	Multi-purpose container
NDA	Nuclear Decommissioning Authority
Nuclear material	Fissile material or material that can be used to produce fissile material (ie source material). This includes most isotopes of uranium, plutonium and thorium, together with certain isotopes of neptunium and americium. In the context of the Derived Inventory, this covers uranium and plutonium and spent fuel.
OPC	Ordinary Portland cement
Packaged volume	The packaged waste volume is the displacement volume of a container used to package a wasteform
PCM	Plutonium contaminated materials
PCSR	Pre-construction safety report
PFA	Pulverised fuel ash
PFR	Prototype Fast Reactor
POCO	Post-operational clean-out
PWR	Pressurised water reactor
RS	Robust shielded
RWM	Radioactive Waste Management Ltd
SF(s)	Spent fuel(s): nuclear fuel removed from a reactor following irradiation that is no longer usable in its present form because of depletion of fissile material, poison build-up or radiation damage
SILW	Shielded Intermediate Level Waste
SLLW	Shielded Low Level Waste
Superplasticiser	Commonly used to improve the flow characteristics of cements and concrete and also allow the water to cement ratio to be reduced (this produces stringer concretes). Superplasticisers could enhance the solubility of actinides.
TDC	Transport Disposal Container
tHM	Tonnes of heavy metal
THORP	Thermal oxide reprocessing plant
TPU	THORP Product Uranium
tU	Tonnes of uranium
UILW	Unshielded Intermediate Level Waste
UK ABWR	UK Advanced boiling water reactor
UK RWI	UK Radioactive Waste Inventory

ULLW	Unshielded Low Level Waste
Wasteform	The waste in the physical and chemical form in which it will be disposed of, including and conditioning media and container furniture (ie in-drum mixing devices, dewatering tubes, etc) but not including the waste container itself or any added inactive capping material

Appendix A Scenario assumptions and method

A1 Scenario 2: Reprocessing less Magnox fuel

A1.1 Legacy HLW and ILW

The reduction in Magnox spent fuel reprocessed results in lower future arisings volumes for waste streams:

- 2D02/C 'Vitrified High Level Waste – Magnox' (HLW)
- 2D27/C 'Encapsulated Floc from Effluent Treatment' (ILW)
- 2D38/C 'Encapsulated Magnox Cladding (ILW)'

All other ILW streams at Sellafield associated with Magnox reprocessing, and which have reported future arisings, are not scalable to the quantity of fuel reprocessed or are generated from plant decommissioning.

2D02/C Vitrified High Level Waste – Magnox

The reduction in future arisings is calculated using the same supporting assumptions as those used for the 2013 Derived inventory. Thus:

- 12.1 kg of oxide product is produced for each tonne of Magnox spent fuel reprocessed for a burn-up of 6 GWd/tU
- the packaging assumptions are the same as those adopted in the 2013 Derived Inventory

Hence, should 3,000 tU Magnox spent fuel remain unreprocessed there would be a reduction in the packaged volume of 360 m^3 and 93 fewer HLW disposal canisters. There would be no arisings in 2016 or 2017 and reduced arisings in 2015.

2D27/C Encapsulated Floc from Effluent Treatment

For stream 2D27/C, the 2013 Derived Inventory future arisings packaged volume is assumed to correspond to:

- reprocessing of 3,000 tU Magnox spent fuel and 2,500 tU AGR and LWR spent fuel
- the stocks of waste stream 2D19 (Aluminium-Ferric Floc from Effluent Treatment). This waste is being retrieved and treated; once treated the waste is transferred to stream 2D27/C

The reduction in future arisings of stream 2D27/C is calculated as follows:

1. deduct stock of 2D19 from the future arisings of 2D27/C. The remaining future arisings of 2D27/C corresponds to the reprocessing of 3,000 tU Magnox and 2,500 tU AGR and LWR spent fuel
2. apportion the remaining future arisings according to spent fuel mass, ie use a factor of 3,000/5,500 for the 3,000 tU Magnox

Should 3,000 tU Magnox spent fuel remain unreprocessed there would be a reduction in stream 2D27/C packaged volume of 1,410 m^3. The reduction in future arisings is deducted from the final years of arisings, which are in the period 1.4.2018 to 31.3.2043.

2D38/C Encapsulated Magnox Cladding

The 2013 Derived Inventory future arisings packaged volume of 1,780 m^3 is assumed to correspond to the reprocessing of 3,000 tU Magnox spent fuel.

A1.2 Legacy Spent Fuel

The remaining 3,000 tU of Magnox spent fuel would require disposal to the GDF. The 2013 Derived Inventory [A1] includes 740 tU of metallic spent fuels from the Sellafield legacy ponds; these fuels were assumed to be Magnox spent fuel and an illustration of a disposal container to accommodate Magnox spent fuel was presented in the 2013 Derived Inventory report along with design assumptions.

The unreprocessed spent fuel would be that which has been most recently discharged from reactors. As a result data from a high burn-up Magnox spent fuel (7.75 GWd/tU) calculation have been used to derive radionuclide activities for the fuel and cladding. This calculation is based on a natural uranium composition (0.71% U235 content). Although some Magnox fuel has been manufactured using slightly enriched uranium and would give a modified radionuclide composition, this factor is not considered significant for the present scoping calculations.

The 3,000 tU of Magnox spent fuel has been assumed to originate in the cores of the Magnox reactors at Wylfa A, Oldbury A, Sizewell A and Dungeness A as these were the last operational reactors. The core fuel inventories for these reactors total 3,023.2 tU [A2]. The date of last operation of each of the reactors has been taken from the PRIS database [A3]. Assuming that it takes two to three years to defuel a reactor core, the stocks and future arisings for the Magnox spent fuel are given in Table A1. Future arisings are based on the assumption that 2/3rd of the Wylfa 2 core was still to be defueled at 1.4.2013 and the Wylfa 1 core will be defuelled between 1.4.2014 and 31.3.2017.

The average cooling time for the stocks has been calculated from the weighted average of the cooling times of the fuel inventories of the different reactors. This is 4.34 years, and has been rounded to 4.0 years for the calculations of the radionuclide inventory. A one-year cooled inventory has been used for future arisings.

Table A1 Magnox spent fuel

Date	Assumed mass (tU)
Stocks at 1.4.2013	2,010
1.4.2013 – 31.3.2014	198
1.4.2014 – 31.3.2015	395
1.4.2015 – 31.3.2016	198
1.4.2016 – 31.3.2017	198
Total	3,000

A1.3 Uranium

This scenario assumes that there is no further reprocessing of Magnox spent fuel and as a consequence, there are no future arisings of stream MU004 (Magnox Depleted Uranium (MDU)). This is equivalent to a reduction of the MDU inventory by 3,000 tonnes (a packaged volume of 2,980 m^3).

A1.4 MOX spent fuel

There would be a reduction in the quantity of separated plutonium for conversion to MOX fuel. This is calculated using the 2013 Derived Inventory assumption that 4,000 tU Magnox spent fuel produces 10 tHM Pu. Hence, the reduction in the quantity of separated plutonium would be 7.5 tHM.

The mass of MOX spent fuel in the 2013 Derived Inventory (1,460 tHM) is based on a plutonium stockpile of the civil plutonium suitable for conversion (95% of 115 tHM) and the Minstry of Defence plutonium (7.6 tHM). The plutonium that would arise from reprocessing the 3,000 tU of Magnox spent fuel is assumed to be suitable for reuse as MOX. Therefore the reduction in the mass of MOX spent fuel should 3,000 tU Magnox spent fuel remain unreprocessed would be 93.8 tHM. Based in the 2013 Derived Inventory package assumptions this is equivalent to a packaged volume of 766 m^3.

A2 Scenario 3: Lifetime extensions for existing reactors

A2.1 Legacy ILW

The additional volume of ILW from life extensions has been calculated using 2013 Derived Inventory data. Average annual arisings for operational waste streams have been calculated and stream volumes extrapolated according to reactor lifetime extensions.

The quantities of waste from reactor defuelling remain unchanged but are rescheduled (EDF includes wastes arising from defuelling in operational streams as the nature of the wastes are similar). The quantity of decommissioning wastes is not dependent on reactor lifetime. However, the waste volumes are rescheduled.

The total additional waste stream arisings for extended reactor operations are given in Table A2.

Table A2 Additional waste stream arisings (stored volume)

Waste stream	Waste group	Waste stream description	Additional arisings	Total additional arisings (m^3)
3J01	UILW	Ion Exchange Material	Additional 1 m^3/y for 10 years.	10.0
3J02	UILW	Sludge	Additional 0.2 m^3/y for 10 years.	2.00
3J03	UILW	Miscellaneous Contaminated Items	Additional 0.1 m^3/y for 10 years.	1.00
3J04	UILW	Desiccants ILW	Based on stock of 85 m^3 over 30 years. Additional 10 years operation= 28.333 m^3 (rounded to 28 m^3).	28.0
3J09	SILW	Miscellaneous Activated Components - Debris Vault 3	Additional 0.3 m^3/y for 10 years.	3.00
3J20	UILW	Catalysts ILW	Additional 0.4 m^3/y for 10 years.	4.00
3J24	UILW	Neutron Scatter Plugs	Additional 1.6 m^3/y for 10 years. Arisings 2105-2108 moved to 2115-2118.	16.0
3J25	UILW	Gag Pistons	No additional waste.	0
3J26	UILW	Miscellaneous Activated Components - Debris Vault 1	Additional 3.6 m^3/y for 10 years.	36.0
3J27	UILW	Miscellaneous Activated Components & Fuel Stringer Debris - Debris Vault 2	Additional 11.4 m^3/y for 10 years.	114

Waste stream	Waste group	Waste stream description	Additional arisings	Total additional arisings (m^3)
3L01	UILW	Pond Water Ion Exchange Material	Additional 0.4 m^3/y for 9 years.	3.60
3L02	UILW	Pond Water Filtration Sludge	Additional 0.4 m^3/y for 9 years.	1.80
3L03	UILW	Miscellaneous Contaminated Items	Additional 0.1 m^3/y for 9 years.	0.900
3L04	UILW	Desiccant	Based on 16.5 m^3 arising in 2017 and 2019. Additional 16.5 m^3 arising in 2023 and 2025.	33.0
3L09	SILW	Miscellaneous Activated Components - Debris Vault 1	Additional 0.35 m^3/y for 9 years.	3.15
3L17	UILW	Gas Circulator Maintenance Sludge	Additional 0.05 m^3/y for 9 years.	0.450
3L19	UILW	Catalyst	Based on stock of 3 m^3 over 29 years. Additional 9 years operation= 0.931 m^3 (rounded to 1 m^3).	1.00
3L20	SILW	Miscellaneous Activated Components - Debris Vault 3	Based on stock of 0.2 m^3 over 29 years. Additional 9 years operation= 0.062 m^3 (rounded to 0.06 m^3).	$6.00\ 10^{-2}$
3L21	SILW	Miscellaneous Activated Components - Spalled Oxide & Dust	Additional 0.4 m^3/y for 9 years.	3.60
3L22	UILW	Fuel Stringer Debris - Debris Vault 4	Additional 5.5 m^3/y for 9 years.	49.5
3L23	UILW	Miscellaneous Activated Components - Tie Bar Ends & Nuts	Additional 0.05 m^3/y for 9 years.	0.450
3L24	UILW	Bypass Blowdown Filters	Additional 1.9 m^3/y for 9 years.	17.1
3L25	UILW	Miscellaneous Activated Components & Fuel Stringer Debris - Debris Vault 2	Additional 2.45 m^3/y for 9 years.	22.1
3M01	UILW	Pond Ion Exchange Material	Additional 0.05 m^3/y for 9 years.	0.450

Waste stream	Waste group	Waste stream description	Additional arisings	Total additional arisings (m^3)
3M02	UILW	Pond Water Filter Sludge	Additional 0.05 m^3/y for 9 years.	0.450
3M03	UILW	Miscellaneous Contaminated Items	Additional 0.3 m^3/y for 9 years.	2.70
3M04	UILW	Desiccant	Based on 20 m^3 arising in 2016 and 2017. Additional 20 m^3 arising in 2025 and 2026.	40.0
3M08	UILW	Active Effluent Ion Exchange Material	Additional 0.05 m^3/y for 9 years.	0.450
3M17	UILW	Catalysts	Based on 13 m^3 arising in 2023. Additional 13 m^3 arising in 2034.	13.0
3M22	SILW	Miscellaneous Activated Components & Fuel Stringer Debris	Additional 8 m^3/y for 9 years.	72.0
3S03	UILW	Spent Cartridge Filters (ILW)	Additional 0.55 m^3/y for 20 years.	11.0
3S05	UILW	Miscellaneous Contaminated Items	Additional 1.7 m^3/y for 20 years.	34.0
3S09	UILW	Miscellaneous Activated Components	Additional 0.5 m^3/y for 20 years.	10.0
3S12	SILW	CVCS Resins & Spent Resins (ILW)	Additional 1.732 m^3/y for 20 years.	34.6

A2.2 Legacy spent fuel

AGRs

The additional mass of AGR spent fuel is based on the 2013 Derived Inventory assumption of 61.2 tU for each year of reactor operation. For the reactor lifetime extensions presented in Table 3.1, there would be an additional 1,770 tU for consignment to the GDF.

The calculation of the radionuclide activity data for the additional AGR spent fuel has been based on the same assumptions used in the 2013 Derived Inventory. Thus, 50% of future spent fuel arisings would be derived from Robust fuel with an initial enrichment of 3.2% and 50% from Robust fuel with an initial enrichment of 3.78%, supporting an average burn-up of 33 GWd/tU. The cladding and fuel impurities inventories are based on a burn-up of 47.5 GWd/tU. Arisings radionuclide activities are taken for one year cooled fuel.

PWR

The additional mass of Sizewell B PWR spent fuel is based on the 2013 Derived Inventory assumption of 27.2 tU for each year of operation. For a lifetime extension of 20 years there would be an additional 545 tU for consignment to the GDF.

The calculation of the radionuclide activity data for the additional Sizewell B PWR spent fuel uses the same assumptions as that for the 2013 Derived Inventory. Thus, the spent fuel arising would have an initial enrichment of 4.4% and a burn-up of 55 GWd/tU. Cladding material for future arisings is assumed to be M5 alloy, which contains 1% niobium [A4]. In calculations a Zircaloy 4 composition is used with an added 1% niobium. The cladding and fuel impurities inventories are based on a burn-up of 61 GWd/tU. Arisings radionuclide activities are taken for one year cooled fuel.

A3 Scenario 4: Recognising UK RWI uncertainty

A3.1 Volume uncertainty – scenarios 4a and 4b

For the majority of waste streams packaging is yet to start, so conditioned and packaged volumes are derived from indicative waste loadings in waste containers. Uncertainties associated with conditioned and packaged waste volumes are not considered in the 2013 UK RWI. However, the 2013 UK RWI contains lower and upper uncertainty factors on the stored volume of waste stream stocks and future arisings. These 'as stored' volume uncertainty factors have been used to estimate uncertainties in conditioned and packaged volumes, and the corresponding numbers of waste disposal packages, with the recognition that for those waste streams that are not yet being packaged these uncertainty estimates are subject to change.

There are a several waste streams where waste producers did not assign volume uncertainty factors in the 2013 UK RWI. For these streams the data gaps have been filled based on similar waste streams and additional information within RWM. Table A3 gives the assumed uncertainty factors for the waste streams where data was missing.

Table A3 Volume uncertainty factors assigned to waste streams with data gaps

Waste stream	Description	Lower volume uncertainty factor	Upper volume uncertainty factor
2D07	Pile Fuel Cladding & Miscellaneous Solid Waste	1.0	1.2
2D08	Magnox Cladding & Miscellaneous Solid Waste	1.0	1.5
2D09	Magnox Cladding & Miscellaneous Solid Waste	1.0	1.5
2D22	Magnox Cladding & Miscellaneous Solid Waste	1.0	1.5
2D24	Magnox Cladding & Miscellaneous Solid Waste	1.0	1.5
2D25	Miscellaneous Solid Waste	1.0	1.5
2D35	Magnox Cladding & Miscellaneous Solid Waste	1.0	1.5
2D73	Miscellaneous Beta/Gamma Waste in Voids	0.9	1.1
2D85.3/C	SPP1 Secondary Waste ILW	0.8	1.5
2D86.3/C	BEP Secondary Waste ILW	0.8	1.5
2D87.1.3/C	SDP Secondary Waste	0.8	1.5
2D132	Plutonium Plants Initial/Interim Decommissioning: Processing Plants (PCM)	0.7	3.0
2D133	Plutonium Plants Initial/Interim Decommissioning: Stores (PCM)	0.7	3.0
2F31	Oxide Fuel Hulls from Early Reprocessing	1.0	1.5
2N01	Plutonium Contaminated Material; Drummed (Legacy Drums)	1.0	1.0
6C31	NDS Contact Handled ILW	0.95	1.05

This scenario does not consider changes in activities, ie the activity is not scaled with volume.

A3.2 Activity uncertainty – scenarios 4c and 4d

The 2013 UK RWI contains lower and upper uncertainty band values on radionuclide specific activities. These values represent the 5% and 95% levels on the cumulative distributions of activity (ie there is a 5% probability of the specific activity being less than the lower limit, and a 95% probability of the activity being less than the upper limit). The uncertainty bands are:

Band A within a factor of 1.5

Band B within a factor of 3

Band C within a factor of 10

Band D within a factor of 100

Band E within a factor of 1,000

Where radionuclide specific activity data have been enhanced for the 2013 Derived Inventory, uncertainty bands have been added. Only for waste stream 2D27/C has an existing 2013 UK RWI uncertainty band value been revised, where it is considered that the Np237 specific activity reported is an upper limit (and hence the upper uncertainty band value has been deleted).

This scenario does not consider changes in waste containers that might result from changes in activity (ie there has been no assessment of package dose rates).

Appendix A References

A1 Radioactive Waste Management, *Geological Disposal: The 2013 Derived Inventory*, DSSC/403/01, 2015.

A2 Nuclear Engineering International, *2013 World Nuclear Industry Handbook, 2013*

A3 IAEA *Power Reactor Information System database*.

A4 NDA, *Generic Design Assessment: Disposability Assessment for Wastes and Spent Fuel arising from operation of the UK EPR – Part 1: Main Report,* NXA/10747397 Issue 2, 2010

Appendix B Scenario assumptions and method

B1 Material data tables

Table B1 Scenario 2 waste material masses for the affected waste groups

Material component	Total mass (tonnes)[21]									
	UILW/ULLW		HLW		Legacy SF		MOX SF		DNLEU	
	2013 DI	Scenario	2013 DI	Scenario	2013 DI	Scenario	2013 DI	Scenario	2013 DI	Scenario
Metals										
Aluminium	1,720	1,710	0	0	0	0	0	0	0	0
Beryllium	24.9	24.9	0	0	0	0	0	0	0	0
Cadmium	4.23	4.23	0	0	0	0	0	0	0	0
Copper	376	376	0	0	0	0	0	0	0	0
Lead	1,120	1,120	0	0	0	0	0	0	0	0
Magnox	6,270	5,850	0	0	133	675	0	0	0	0
Other ferrous metals	38,300	38,300	1.18	1.18	0	0	0	0	13,400	13,400
Stainless steel	32,300	32,300	612	588	1,380	2,670	39.5	37.0	6,400	6,210
Uranium	941	910	0	0	740	3,740	0	0	0	0
Zinc	74.1	74.1	0	0	0	0	0	0	0	0

21 All cementitious materials are assumed to contain 0.5% by mass superplasticiser.

Material component	Total mass (tonnes)[21]									
	UILW/ULLW		HLW		Legacy SF		MOX SF		DNLEU	
	2013 DI	Scenario	2013 DI	Scenario	2013 DI	Scenario	2013 DI	Scenario	2013 DI	Scenario
Zircaloy	1,240	1,240	0	0	269	269	438	410	0	0
Other metals	551	549	20.6	20.6	18.1	18.1	11.8	11.0		0
Total metals	82,900	82,400	634	610	2,540	7,370	490	458	19,800	19,600
Organics										
Cellulosics	2,580	2,580	0	0	0	0	0	0	0	0
Halogenated plastics	4,720	4,720	0	0	0	0	0	0	0	0
Non-halogenated plastics	2,330	2,330	0	0	0	0	0	0	137	136
Organic ion exchange resins	51.9	51.9	0	0	0	0	0	0	0	0
Rubbers	1,950	1,950	0	0	0	0	0	0	0	0
Other organics	456	456	0	0	0	0	0	0	0	0
Total organics	12,100	12,100	0	0	0	0	0	0	137	136
Other materials										
Asbestos	295	295	0	0	0	0	0	0	0	0
Graphite	13,900	13,900	0	0	0	0	0	0	0	0
Aqueous liquids	8,850	8,850	0	0	0	0	0	0	0	0
Cement / concrete / sand	52,100	48,900	0	0	0	0	0	0	0	0

Material component	Total mass (tonnes)[21]									
	UILW/ULLW		HLW		Legacy SF		MOX SF		DNLEU	
	2013 DI	Scenario	2013 DI	Scenario	2013 DI	Scenario	2013 DI	Scenario	2013 DI	Scenario
Ceramic	211	211	0	0	35.1	35.1	1.61	1.51	0	0
Desiccants	587	587	0	0	0	0	0	0	0	0
Glass	218	218	2,850	2,730	0	0	0	0	0	0
Heavy metal oxide	0	0	0	0	6,310	6,310	1,660	1,550	219,000	215,000
Ion exchange materials	3,230	3,230	0	0	0	0	0	0	0	0
Rubble	2,180	2,180	0	0	0	0	0	0	0	0
Sludge / flocs	22,200	21,300	0	0	0	0	0	0	0	0
Soil	5.25	5.25	0	0	0	0	0	0	0	0
Other inorganics	2.49	2.49	0	0	0	0	0	0	0	0
Total other materials	104,000	99,700	2,850	2,730	6,340	6,340	1,660	1,550	219,000	215,000

Table B2 Scenario 2 conditioning and capping material masses for the affected waste groups

Material component	Total mass (tonnes)[22]			
	UILW/ULLW		DNLEU	
	2013 DI	Scenario	2013 DI	Scenario
Conditioning materials				
OPC	39,100	39,100	18,300	18,200
BFS or PFA	138,000	138,000	44,500	44,000
Polymer	207	207	0	0
Water	72,400	72,400	25,900	25,600
Stainless steel	0	0	238	238
Total conditioning materials	250,000	250,000	89,000	88,000
Capping materials				
OPC	6,980	6,910	456	456
PFA	20,900	20,700	1,370	1,370
Water	4,890	4,840	319	319
Iron shot concrete	0	0	0	0
Total capping materials	32,800	32,500	2,140	2,140

22 All cementitious materials are assumed to contain 0.5% by mass superplasticiser

Table B3 Scenario 2 disposal container material masses for the affected waste groups

Material component	Total mass (tonnes)[23]									
	UILW / ULLW		HLW		Legacy SF		MOX SF		DNLEU	
	2013 DI	Scenario	2013 DI	Scenario	2013 DI	Scenario	2013 DI	Scenario	2013 DI	Scenario
Metals										
Stainless steel	82,100	81,400	0	0	0	0	0	0	28,500	28,000
Lead	0	0	0	0	0	0	0	0	0	0
Copper	0	0	17,800	17,100	28,000	53,900	22,300	20,800	0	0
Carbon steel	3,010	3,010	2,540	2,440	689	689	0	0	0	0
Cast iron	0	0	37,800	36,400	56,700	104,000	63,100	59,100	0	0
Total metals	85,100	84,400	58,100	55,900	85,400	159,000	85,400	79,900	28,500	28,000
Other materials										
Concrete	50,800	50,800	0	0	0	0	0	0	0	0
Reinforced concrete	0	0	0	0	0	0	0	0	0	0
Magnetite concrete	0	0	0	0	0	0	0	0	0	0
Total other materials	50,800	50,800	0	0	0	0	0	0	0	0

23 All concrete container material is assumed to contain 0.5% by mass superplasticiser

Table B4 Scenario 3 waste material masses for the affected waste groups

Material component	Total mass (tonnes)[24]							
	UILW / ULLW		SILW / SLLW		RSCs		Legacy SF	
	2013 DI	Scenario	2013 DI	Scenario	2013 DI	Scenario	2013 DI	Scenario
Metals								
Aluminium	1,720	1,720	23.9	23.9	1.53	1.53	0	0
Beryllium	24.9	24.9	18.4	18.40	$4.00\ 10^{-3}$	$4.00\ 10^{-3}$	0	0
Cadmium	4.23	4.23	0.158	0.158	0	0	0	0
Copper	376	376	23.5	23.5	$8.20\ 10^{-2}$	$8.20\ 10^{-2}$	0	0
Lead	1,120	1,120	5.79	5.79	0.143	0.143	0	0
Magnox	6,270	6,270	16.0	16.0	90.7	90.7	133	133
Other ferrous metals	38,300	38,300	14,500	14,500	251	251	0.00	0.000
Stainless steel	32,300	32,500	2,900	2,930	187	187	1,380	1,800
Uranium	941	941	0	0	0.191	0.191	740	740
Zinc	74.1	74.1	0	0	0.101	0.101	0	0
Zircaloy	1,240	1,240	16.6	16.6	28.9	28.9	269	409
Other metals	551	568	15.1	16.9	2.92	2.92	18.1	26.0
Total metals	82,900	83,100	17,500	17,600	562	562	2,540	3,110

24 All cementitious materials are assumed to contain 0.5% by mass superplasticiser.

Material component	Total mass (tonnes)[24]							
	UILW / ULLW		SILW / SLLW		RSCs		Legacy SF	
	2013 DI	Scenario	2013 DI	Scenario	2013 DI	Scenario	2013 DI	Scenario
Organics								
Cellulosics	2,580	2,580	8.69	8.69	24.0	24.0	0	0
Halogenated plastics	4,720	4,720	14.6	14.6	17.8	17.8	0	0
Non-halogenated plastics	2,330	2,330	281	281	22.7	22.7	0	0
Organic ion exchange resins	51.9	52.8	97.4	97.4	377	413	0	0
Rubbers	1,950	1,950	2.87	2.87	5.51	5.51	0	0
Other organics	456	456	0.200	0.200	17.6	17.6	0	0
Total organics	12,100	12,100	405	405	464	501	0	0
Other materials								
Asbestos	295	295	0.269	0.269	2.57	2.57	0	0
Graphite	13,900	14,000	62,500	62,500	493	493	0	0
Aqueous liquids	8,850	8,850	0	0	17.2	17.2	0	0
Cement / concrete / sand	52,100	52,100	1,650	1,650	164	164	0	0
Ceramic	211	213	0	0	$6.60\ 10^{-2}$	$6.60\ 10^{-2}$	35	49
Desiccants	587	677	0	0	61.5	61.5	0	0
Glass	218	219	2.87	2.87	7.70	7.70	0	0
Heavy metal oxide	0	0	0	0	0	0	6,310	8,930

Material component	Total mass (tonnes)[24]							
	UILW / ULLW		SILW / SLLW		RSCs		Legacy SF	
	2013 DI	Scenario	2013 DI	Scenario	2013 DI	Scenario	2013 DI	Scenario
Ion exchange materials	3,230	3,230	167	167	39.3	39.3	0	0
Rubble	2,180	2,180	5.38	5.38	391	391	0	0
Sludge / flocs	22,200	22,200	0	0	319	319	0	0
Soil	5.25	5.25	0	0	$6.00\ 10^{-2}$	$6.00\ 10^{-2}$	0	0
Other inorganics	2.49	2.49	0	0	0	0	0	0
Total other materials	104,000	104,000	64,300	64,300	1,500	1,500	6,340	8,980

Table B5 Scenario 3 conditioning and capping material masses for the affected waste groups

Material component	Total mass (tonnes)[25]			
	UILW / ULLW		SILW / SLLW	
	2013 DI	Scenario	2013 DI	Scenario
Conditioning materials				
OPC	39,100	39,200	4,570	4,570
BFS or PFA	138,000	138,000	13,700	13,700
Polymer	207	207	205	205
Water	72,400	72,500	7,460	7,470
Stainless steel	0	0	0	0
Total conditioning materials	250,000	250,000	25,900	26,000
Capping materials				
OPC	6,980	7,000	23.2	23.2
PFA	20,900	21,000	69.5	69.5
Water	4,890	4,900	16.2	16.2
Iron shot concrete	0	0	23,000	23,000
Total capping materials	32,800	32,900	23,100	23,100

25 All cementitious materials are assumed to contain 0.5% by mass superplasticiser.

Table B6 Scenario 3 disposal container material masses for the affected waste groups

Material component	Total mass (tonnes)[26]							
	UILW / ULLW		SILW / SLLW		RSCs		Legacy SF	
	2013 DI	Scenario	2013 DI	Scenario	2013 DI	Scenario	2013 DI	Scenario
Metals								
Stainless steel	82,100	82,300	22,000	22,000	0	0	0	0
Lead	0	0	0	0	562	562	0	0
Copper	0	0	0	0	0	0	28,000	36,900
Carbon steel	3,010	3,010	298	298	0	0	689	978
Cast iron	0	0	0	0	26,100	26,500	56,700	75,300
Total metals	85,100	85,300	22,300	22,300	26,600	27,100	85,400	113,000
Other materials								
Concrete	50,800	50,800	22,400	22,600	0	0	0	0
Reinforced concrete	0	0	4,390	4,390	0	0	0	0
Magnetite concrete	0	0	2,410	2,410	0	0	0	0
Total other materials	50,800	50,800	29,200	29,400	0	0	0	0

26 All concrete container material is assumed to contain 0.5% by mass superplasticiser.

Table B7 Scenario 4 lower uncertainty volume waste material masses for the affected waste groups

Material component	Total mass (tonnes)[27]							
	UILW / ULLW		SILW / SLLW		RSCs		HLW	
	2013 DI	Scenario	2013 DI	Scenario	2013 DI	Scenario	2013 DI	Scenario
Metals								
Aluminium	1,720	1,440	23.9	13.8	1.53	1.25	0	0
Beryllium	24.9	18.5	18.4	9.26	$4.00\ 10^{-3}$	$3.00\ 10^{-3}$	0	0
Cadmium	4.23	2.58	0.158	0.126	0	0	0	0
Copper	376	305	23.5	13.4	$8.20\ 10^{-2}$	$6.60\ 10^{-2}$	0	0
Lead	1,120	908	5.79	5.17	0.143	0.114	0	0
Magnox	6,270	5,830	16.0	12.3	90.7	76.0	0	0
Other ferrous metals	38,300	27,600	14,500	9,790	251	154	1.18	0.390
Stainless steel	32,300	24,400	2,900	1,790	187	142	612	475
Uranium	941	876	0	0	0.191	0.162	0	0
Zinc	74.1	60.8	0	0	0.101	$8.10\ 10^{-2}$	0	0
Zircaloy	1,240	1,120	16.6	14.1	28.9	26.0	0	0
Other metals	551	405	15.1	10.1	2.92	2.48	20.6	6.78
Total metals	82,900	63,000	17,500	11,700	562	402	634	482

27 All cementitious materials are assumed to contain 0.5% by mass superplasticiser.

Material component	Total mass (tonnes)[27]							
	UILW / ULLW		SILW / SLLW		RSCs		HLW	
	2013 DI	Scenario	2013 DI	Scenario	2013 DI	Scenario	2013 DI	Scenario
Organics								
Cellulosics	2,580	2,080	8.69	8.05	24.0	9.51	0	0
Halogenated plastics	4,720	3,730	14.6	14.4	17.8	8.32	0	0
Non-halogenated plastics	2,330	1,850	281	227	22.7	13.0	0	0
Organic ion exchange resins	51.9	37.8	97.4	77.9	377	334	0	0
Rubbers	1,950	1,530	2.87	2.85	5.51	4.48	0	0
Other organics	456	365	0.200	0.160	17.6	15.1	0	0
Total organics	12,100	9,590	405	331	464	384	0	0
Other materials								
Asbestos	295	239	0.269	0.269	2.57	1.41	0	0
Graphite	13,900	10,700	62,500	39,400	493	443	0	0
Aqueous liquids	8,850	7,890	0	0	17.2	13.7	0	0
Cement / concrete / sand	52,100	43,500	1,650	1,280	164	107	0	0
Ceramic	211	193	0	0	$6.60\ 10^{-2}$	$5.30\ 10^{-2}$	0	0
Desiccants	587	418	0	0	61.5	53.5	0	0
Glass	218	166	2.87	2.85	7.70	6.90	2,850	2,220

Material component	Total mass (tonnes)[27]							
	UILW / ULLW		SILW / SLLW		RSCs		HLW	
	2013 DI	Scenario	2013 DI	Scenario	2013 DI	Scenario	2013 DI	Scenario
Heavy metal oxide	0	0	0	0	0	0	0	0
Ion exchange materials	3,230	2,670	167	133	39.3	32.4	0	0
Rubble	2,180	1,810	5.38	5.38	391	308	0	0
Sludge / flocs	22,200	19,500	0	0	319	277	0	0
Soil	5.25	4.60	0	0	$6.00\ 10^{-2}$	$4.80\ 10^{-2}$	0	0
Other inorganics	2.49	2.32	0	0	0	0	0	0
Total other materials	104,000	87,100	64,300	40,800	1,500	1,240	2,850	2,220

Table B8 Scenario 4 lower uncertainty volume conditioning and capping material masses for the affected waste groups

Material component	Total mass (tonnes)[28]			
	UILW / ULLW		SILW / SLLW	
	2013 DI	Scenario	2013 DI	Scenario
Conditioning materials				
OPC	39,100	28,700	4,570	3,080
BFS or PFA	138,000	105,000	13,700	9,230
Polymer	207	104	205	102
Water	72,400	54,700	7,460	5,020
Stainless steel	0	0	0	0
Total conditioning materials	250,000	189,000	25,900	17,400
Capping materials				
OPC	6,980	5,470	23.2	18.2
PFA	20,900	16,400	69.5	54.7
Water	4,890	3,830	16.2	12.8
Iron shot concrete	0	0	23,000	14,900
Total capping materials	32,800	25,700	23,100	15,000

28 All cementitious materials are assumed to contain 0.5% by mass superplasticiser.

Table B9 Scenario 4 lower uncertainty volume disposal container material masses for the affected waste groups

Material component	Total mass (tonnes)[29]							
	UILW / ULLW		SILW / SLLW		RSCs		HLW	
	2013 DI	Scenario	2013 DI	Scenario	2013 DI	Scenario	2013 DI	Scenario
Metals								
Stainless steel	82,100	66,600	22,000	14,200	0	0	0	0
Lead	0	0	0	0	562	520	0	0
Copper	0	0	0	0	0	0	17,800	13,800
Carbon steel	3,010	2,690	298	239	0	0	2,540	1,980
Cast iron	0	0	0	0	26,100	22,300	37,800	29,400
Total metals	85,100	69,300	22,300	14,400	26,600	22,800	58,100	45,200
Other materials								
Concrete	50,800	40,600	22,400	16,100	0	0	0	0
Reinforced concrete	0	0	4,390	3,460	0	0	0	0
Magnetite concrete	0	0	2,410	2,050	0	0	0	0
Total other materials	50,800	40,600	29,200	21,600	0	0	0	0

29 All concrete container material is assumed to contain 0.5% by mass superplasticiser.

Table B10 Scenario 4 upper uncertainty volume waste material masses for the affected waste groups

Material component	Total mass (tonnes)[30]							
	UILW / ULLW		SILW / SLLW		RSCs		HLW	
	2013 DI	Scenario	2013 DI	Scenario	2013 DI	Scenario	2013 DI	Scenario
Metals								
Aluminium	1,720	2,560	23.9	34.8	1.53	1.81	0	0
Beryllium	24.9	50.3	18.4	27.5	$4.00\ 10^{-3}$	$4.00\ 10^{-3}$	0	0
Cadmium	4.23	8.33	0.158	0.189	0	0	0	0
Copper	376	641	23.5	33.7	$8.20\ 10^{-2}$	$9.90\ 10^{-2}$	0	0
Lead	1,120	1,380	5.79	6.41	0.143	0.172	0	0
Magnox	6,270	7,770	16.0	19.6	90.7	111	0	0
Other ferrous metals	38,300	57,500	14,500	19,400	251	368	1.18	3.540
Stainless steel	32,300	58,200	2,900	4,030	187	230	612	1,440
Uranium	941	1,210	0	0	0.191	0.220	0	0
Zinc	74.1	107.0	0	0	0.101	0.121	0	0
Zircaloy	1,240	1,370	16.6	19.1	28.9	31.8	0	0
Other metals	551	680	15.1	20.7	2.92	3.36	20.6	61.7
Total metals	82,900	132,000	17,500	23,600	562	746	634	1,500

30 All cementitious materials are assumed to contain 0.5% by mass superplasticiser.

Material component	Total mass (tonnes)[30]							
	UILW / ULLW		SILW / SLLW		RSCs		HLW	
	2013 DI	Scenario	2013 DI	Scenario	2013 DI	Scenario	2013 DI	Scenario
Organics								
Cellulosics	2,580	3,650	8.69	9.34	24.0	39.9	0	0
Halogenated plastics	4,720	7,720	14.6	14.8	17.8	28.4	0	0
Non-halogenated plastics	2,330	3,670	281	334	22.7	33.1	0	0
Organic ion exchange resins	51.9	68.5	97.4	117.0	377	421	0	0
Rubbers	1,950	3,040	2.87	2.89	5.51	6.53	0	0
Other organics	456	546	0.200	0.400	17.6	20.3	0	0
Total organics	12,100	18,700	405	479	464	550	0	0
Other materials								
Asbestos	295	358	0.269	0.269	2.57	4.30	0	0
Graphite	13,900	17,200	62,500	86,600	493	543	0	0
Aqueous liquids	8,850	13,200	0	0	17.2	20.6	0	0
Cement / concrete / sand	52,100	81,200	1,650	1,780	164	237	0	0
Ceramic	211	305	0	0	$6.60\ 10^{-2}$	$7.90\ 10^{-2}$	0	0
Desiccants	587	756	0	0	61.5	69.7	0	0
Glass	218	320	2.87	2.89	7.70	8.50	2,850	6,680

Material component	Total mass (tonnes)[30]							
	UILW / ULLW		SILW / SLLW		RSCs		HLW	
	2013 DI	Scenario	2013 DI	Scenario	2013 DI	Scenario	2013 DI	Scenario
Heavy metal oxide	0	0	0	0	0	0	0	0
Ion exchange materials	3,230	4,240	167	200	39.3	54.3	0	0
Rubble	2,180	2,660	5.38	5.38	391	501	0	0
Sludge / flocs	22,200	27,400	0	0	319	386	0	0
Soil	5.25	5.90	0	0	$6.00\ 10^{-2}$	$7.20\ 10^{-2}$	0	0
Other inorganics	2.49	2.66	0	0	0	0	0	0
Total other materials	104,000	148,000	64,300	88,600	1,500	1,820	2,850	6,680

Table B11 Scenario 4 upper uncertainty volume conditioning and capping material masses for the affected waste groups

Material component	Total mass (tonnes)[31]			
	UILW / ULLW		SILW / SLLW	
	2013 DI	Scenario	2013 DI	Scenario
Conditioning materials				
OPC	39,100	96,700	4,570	6,130
BFS or PFA	138,000	318,000	13,700	18,400
Polymer	207	344	205	307
Water	72,400	170,000	7,460	10,000
Stainless steel	0	0	0	0
Total conditioning materials	250,000	585,000	25,900	34,900
Capping materials				
OPC	6,980	13,900	23.2	26.9
PFA	20,900	41,700	69.5	80.8
Water	4,890	9,730	16.2	18.8
Iron shot concrete	0	0	23,000	31,400
Total capping materials	32,800	65,300	23,100	31,500

31 All cementitious materials are assumed to contain 0.5% by mass superplasticiser.

Table B12 Scenario 4 upper uncertainty volume disposal container material masses for the affected waste groups

Material component	Total mass (tonnes)[32]							
	UILW / ULLW		SILW / SLLW		RSCs		HLW	
	2013 DI	Scenario	2013 DI	Scenario	2013 DI	Scenario	2013 DI	Scenario
Metals								
Stainless steel	82,100	157,000	22,000	30,200	0	0	0	0
Lead	0	0	0	0	562	626	0	0
Copper	0	0	0	0	0	0	17,800	41,800
Carbon steel	3,010	3,330	298	345	0	0	2,540	5,980
Cast iron	0	0	0	0	26,100	30,600	37,800	88,900
Total metals	85,100	160,000	22,300	30,500	26,600	31,200	58,100	137,000
Other materials								
Concrete	50,800	109,000	22,400	28,900	0	0	0	0
Reinforced concrete	0	0	4,390	5,100	0	0	0	0
Magnetite concrete	0	0	2,410	2,770	0	0	0	0
Total other materials	50,800	109,000	29,200	36,800	0	0	0	0

32 All concrete container material is assumed to contain 0.5% by mass superplasticiser

Table B13 Scenario 8 new build waste material masses per EPR

Material component	Total mass (tonnes)		
	NB UILW	NB SILW	NB SF
Metals			
Aluminium	0	0	0
Beryllium	0	0	0
Cadmium	0	0	0
Copper	0	0	0
Lead	0	0	0
Magnox	0	0	0
Other ferrous metals	0	181	0
Stainless steel	215	86.2	38.1
Uranium	0	0	0
Zinc	0	0	0
Zircaloy	0	0	423
Other metals	0	0	11.4
Total metals	215	267	472
Organics			
Cellulosics	0	2.64	0
Halogenated plastics	0	4.32	0
Non-halogenated plastics	0	19.3	0
Organic ion exchange resins	0	180	0
Rubbers	0	1.10	0
Other organics	0	1.20	0
Total organics	0	209	0
Other materials			
Asbestos	0	0	0
Graphite	0	0	0
Aqueous liquids	0	6.17	0
Cement / concrete / sand	0	0	0
Ceramic	0	1.20	1.55

Material component	Total mass (tonnes)		
	NB UILW	NB SILW	NB SF
Desiccants	0	0	0
Glass	0	0.900	0
Heavy metal oxide	0	0	1,561
Ion exchange materials	0	0	0
Rubble	0	0.240	0
Sludge / flocs	0	72.0	0
Soil	0	0	0
Other inorganics	0	0	0
Total other materials	0	80.5	1,562

Table B14 Scenario 8 new build conditioning and capping material masses for the affected waste groups per EPR

Material component	Total mass (tonnes)[33]	
	NB UILW	NB SILW
Conditioning materials		
OPC	51.4	88.7
BFS or PFA	154	301
Polymer	0	142
Water	84.0	159
Stainless steel	0	0
Total conditioning materials	290	691
Capping materials		
OPC	4.99	0
PFA	15.0	0
Water	3.49	0
Iron shot concrete	0	0
Total capping materials	23.4	0

33 All cementitious materials are assumed to contain 0.5% by mass superplasticiser.

Table B15 Scenario 8 new build container material masses per EPR

Material component	Total mass (tonnes)[34]		
	NB UILW	NB SILW	NB SF
Metals			
Stainless steel	53.2	50.0	0
Lead	0	0	0
Copper	0	0	7,160
Carbon steel	0	2,220	0
Cast iron	0	0	17,300
Total metals	53.2	2,270	24,400
Other materials			
Concrete	0	125	0
Reinforced concrete	0	3,790	0
Magnetite concrete	0	0	0
Total other materials	0	3,910	0

34 All concrete container material is assumed to contain 0.5% by mass superplasticiser

Table B16 Scenario 8 new build waste material masses per AP1000

Material component	Total mass (tonnes)	
	NB UILW	NB SF
Metals		
Aluminium	0	
Beryllium	0	0
Cadmium	0	0
Copper	0	0
Lead	0	0
Magnox	0	0
Other ferrous metals	306	0
Stainless steel	166	27.1
Uranium	0	0
Zinc	0	0
Zircaloy	0	291
Other metals	0	9.63
Total metals	472	327
Organics		
Cellulosics	0	0
Halogenated plastics	0	0
Non-halogenated plastics	0.454	0
Organic ion exchange resins	338	0
Rubbers	$9.72\ 10^{-3}$	0
Other organics	0	0
Total organics	338	0
Other materials		
Asbestos	0	0
Graphite	0	0
Aqueous liquids	0.444	0
Cement / concrete / sand	0	0
Ceramic	0	1.05

Material component	Total mass (tonnes)	
	NB UILW	NB SF
Desiccants	0	0
Glass	$6.48\ 10^{-2}$	0
Heavy metal oxide	0	1,139
Ion exchange materials	338	0
Rubble	0	0
Sludge / flocs	0	0
Soil	0	0
Other inorganics	0	0
Total other materials	338	1,140

Table B17 Scenario 8 new build conditioning and capping material masses for the affected waste groups per AP1000

Material component	Total mass (tonnes)[35]
	NB UILW
Conditioning materials:	
OPC	309
BFS or PFA	2,481
Polymer	0
Water	1,140
Stainless steel	0
Total conditioning materials	3,930
Capping materials:	
OPC	309
PFA	58.5
Water	1,140
Iron shot concrete	0
Total capping materials	1,510

35 All cementitious materials are assumed to contain 0.5% by mass superplasticiser.

Table B18 Scenario 8 new build container material masses per AP1000

Material component	Total mass (tonnes)[36]	
	NB UILW	NB SF
Metals		
Stainless steel	551	0
Lead	0	0
Copper	0	5,100
Carbon steel	0	0
Cast iron	0	12,300
Total metals	551	17,400
Other materials		
Concrete	0	0
Reinforced concrete	0	0
Magnetite concrete	0	0
Total other materials	0	0

36 All concrete container material is assumed to contain 0.5% by mass superplasticiser

Table B19 Scenario 11 waste material masses for the affected waste groups

Material component	Total mass (tonnes)[37]			
	UILW / ULLW		SILW / SLLW	
	2013 DI	Scenario	2013 DI	Scenario
Metals				
Aluminium	1,720	1,720	23.9	23.9
Beryllium	24.9	24.9	18.4	18.40
Cadmium	4.23	4.23	0.158	0.158
Copper	376	376	23.5	23.5
Lead	1,120	1,120	5.79	5.79
Magnox	6,270	6,270	16.0	16.0
Other ferrous metals	38,300	38,300	14,500	14,500
Stainless steel	32,300	32,300	2,900	2,900
Uranium	941	941	0	0
Zinc	74.1	74.1	0	0
Zircaloy	1,240	1,240	16.6	16.6
Other metals	551	551	15.1	15.1
Total metals	82,900	82,900	17,500	17,500
Organics				
Cellulosics	2,580	2,580	8.69	8.69
Halogenated plastics	4,720	4,720	14.6	14.6
Non-halogenated plastics	2,330	2,330	281	281
Organic ion exchange resins	51.9	51.9	97.4	97.4
Rubbers	1,950	1,950	2.87	2.87
Other organics	456	456	0.200	0.200
Total organics	12,100	12,100	405	405
Other materials				
Asbestos	295	295	0.269	0.269
Graphite	13,900	948	62,500	358

37 All cementitious materials are assumed to contain 0.5% by mass superplasticiser.

Material component	Total mass (tonnes)[37]			
	UILW / ULLW		SILW / SLLW	
	2013 DI	Scenario	2013 DI	Scenario
Aqueous liquids	8,850	8,850	0	0
Cement / concrete / sand	52,100	52,100	1,650	1,650
Ceramic	211	211	0	0
Desiccants	587	587	0	0
Glass	218	218	2.87	2.87
Heavy metal oxide	0	0	0	0
Ion exchange materials	3,230	3,230	167	167
Rubble	2,180	2,180	5.38	5.38
Sludge / flocs	22,200	22,200	0	0
Soil	5.25	5.25	0	0
Other inorganics	2.49	2.49	0	0
Total other materials	104,000	90,700	64,300	2,190

Table B20 Scenario 11 conditioning and capping material masses for the affected waste groups

Material component	Total mass (tonnes)[38]			
	UILW / ULLW		SILW / SLLW	
	2013 DI	Scenario	2013 DI	Scenario
Conditioning materials				
OPC	39,100	37,100	4,570	1,500
BFS or PFA	138,000	132,000	13,700	4,510
Polymer	207	207	205	205
Water	72,400	69,000	7,460	2,460
Stainless steel	0	0	0	0
Total conditioning materials	250,000	238,000	25,900	8,670
Capping materials				
OPC	6,980	6,430	23.2	13.9
PFA	20,900	19,300	69.5	41.8
Water	4,890	4,500	16.2	9.76
Iron shot concrete	0	0	23,000	6,520
Total capping materials	32,800	30,200	23,100	6,590

38 All cementitious materials are assumed to contain 0.5% by mass superplasticiser.

Table B21 Scenario 11 disposal container material masses for the affected waste groups

Material component	Total mass (tonnes)[39]			
	UILW / ULLW		SILW / SLLW	
	2013 DI	Scenario	2013 DI	Scenario
Metals				
Stainless steel	82,100	76,500	22,000	5,570
Lead	0	0	0	0
Copper	0	0	0	0
Carbon steel	3,010	3,010	298	206
Cast iron	0	0	0	0
Total metals	85,100	79,500	22,300	5,780
Other materials				
Concrete	50,800	48,000	22,400	11,000
Reinforced concrete	0	0	4,390	2,640
Magnetite concrete	0	0	2,410	2,410
Total other materials	50,800	48,000	29,200	16,100

39 All concrete container material is assumed to contain 0.5% by mass superplasticiser

Table B22 Scenario 12 waste material masses for the affected waste groups

Material component	Total mass (tonnes) [40]					
	UILW / ULLW		SILW / SLLW		RSCs	
	2013 DI	Scenario	2013 DI	Scenario	2013 DI	Scenario
Metals						
Aluminium	1,720	1,710	23.9	23.8	1.53	1.53
Beryllium	24.9	24.9	18.4	18.40	$4.00\ 10^{-3}$	$4.00\ 10^{-3}$
Cadmium	4.23	4.23	0.158	0.158	0	0
Copper	376	376	23.5	23.5	$8.20\ 10^{-2}$	$8.20\ 10^{-2}$
Lead	1,120	705	5.79	5.75	0.143	0.143
Magnox	6,270	6,270	16.0	16.0	90.7	90.7
Other ferrous metals	38,300	37,100	14,500	14,500	251	251
Stainless steel	32,300	28,500	2,900	2,880	187	187
Uranium	941	941	0	0	0.191	0.191
Zinc	74.1	74.1	0	0	0.101	0.101
Zircaloy	1,240	1,240	16.6	16.6	28.9	28.9
Other metals	551	371	15.1	15.1	2.92	2.92
Total metals	82,900	77,300	17,500	17,500	562	562
Organics						
Cellulosics	2,580	2,560	8.69	8.69	24.0	24.00
Halogenated plastics	4,720	4,710	14.6	14.6	17.8	17.70
Non-halogenated plastics	2,330	2,320	281	281	22.7	22.6
Organic ion exchange resins	51.9	4.7	97.4	97.4	377	377
Rubbers	1,950	1,950	2.87	2.83	5.51	5.19
Other organics	456	451	0.200	0.200	17.6	17.1
Total organics	12,100	12,000	405	405	464	464
Other materials:						
Asbestos	295	295	0.269	0.269	2.57	2.57

40 All cementitious materials are assumed to contain 0.5% by mass superplasticiser.

Material component	Total mass (tonnes) (40)					
	UILW / ULLW		SILW / SLLW		RSCs	
	2013 DI	Scenario	2013 DI	Scenario	2013 DI	Scenario
Graphite	13,900	13,900	62,500	62,500	493	493
Aqueous liquids	8,850	8,830	0	0	17.2	17.2
Cement / concrete / sand	52,100	52,100	1,650	1,650	164	158
Ceramic	211	206	0	0	$6.60\ 10^{-2}$	$6.60\ 10^{-2}$
Desiccants	587	18.3	0	0	61.5	1.80
Glass	218	208	2.87	2.83	7.70	7.70
Heavy metal oxide	0	0	0	0	0	0
Ion exchange materials	3,230	3,230	167	167	39.3	39.3
Rubble	2,180	2,180	5.38	5.38	391	387
Sludge / flocs	22,200	22,100	0	0	319	317
Soil	5.25	5.25	0	0	$6.00\ 10^{-2}$	$6.00\ 10^{-2}$
Other inorganics	2.49	2.49	0	0	0	0
Total other materials	104,000	103,000	64,300	64,300	1,500	1,420

Table B23 Scenario 12 conditioning and capping material masses for the affected waste groups

Material component	Total mass (tonnes)[41]			
	UILW / ULLW		SILW / SLLW	
	2013 DI	Scenario	2013 DI	Scenario
Conditioning materials				
OPC	39,100	38,600	4,570	4,550
BFS or PFA	138,000	136,000	13,700	13,700
Polymer	207	207	205	205
Water	72,400	71,500	7,460	7,440
Stainless steel	0	0	0	0
Total conditioning materials	250,000	247,000	25,900	25,900
Capping materials				
OPC	6,980	6,800	23.2	23.2
PFA	20,900	20,400	69.5	69.5
Water	4,890	4,760	16.2	16.2
Iron shot concrete	0	0	23,000	22,900
Total capping materials	32,800	32,000	23,100	23,000

41 All cementitious materials are assumed to contain 0.5% by mass superplasticiser.

Table B24 Scenario 12 disposal container material masses for the affected waste groups

Material component	Total mass (tonnes)[42]					
	UILW / ULLW		SILW / SLLW		RSCs	
	2013 DI	Scenario	2013 DI	Scenario	2013 DI	Scenario
Metals						
Stainless steel	82,100	80,300	22,000	21,900	0	0
Lead	0	0	0	0	562	562
Copper	0	0	0	0	0	0
Carbon steel	3,010	3,010	298	298	0	0
Cast iron	0	0	0	0	26,100	24,400
Total metals	85,100	83,300	22,300	22,200	26,600	25,000
Other materials						
Concrete	50,800	50,800	22,400	22,400	0	0
Reinforced concrete	0	0	4,390	4,390	0	0
Magnetite concrete	0	0	2,410	2,410	0	0
Total other materials	50,800	50,800	29,200	29,200	0	0

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42 All concrete container material is assumed to contain 0.5% by mass superplasticiser.

B2 Waste container tables

Table B25 Scenario 2: waste packages, disposal units, conditioned volumes and packaged volumes, presented by waste group.

Waste container	No. packages	No. Disposal Units	Conditioned Volume (m^3)	Packaged Volume (m^3)
SILW / SLLW				
2m box (100 mm concrete)	75	75	334	758
4m box (0 mm concrete)	2,760	2,760	52,100	55,300
4m box (100 mm concrete)	1,190	1,190	17,100	23,900
4m box (200 mm concrete)	399	399	4,350	7,990
6 m^3 box (High density)	96	96	544	1,130
6 m^3 box (Standard density)	330	330	1,900	3,910
Total SILW	4,850	4,850	76,300	93,000
UILW / ULLW				
3 m^3 box (round corners)	4,770	4,770	12,700	15,600
3 m^3 box (square corners)	403	403	1,120	1,450
3 m^3 drum	563	563	1,260	1,470
3 m^3 Sellafield box	54,300	54,300	147,000	179,000
3 m^3 Enhanced Sellafield box	16,300	16,300	35,100	53,900
500 l drum	86,200	21,500	40,000	49,000
MBGWS box	1,500	1,500	5,270	7,070
Enhanced 500 l drum (basket)	26,100	6,520	13,200	14,900
Enhanced 500 l drum (pre-cast)	893	223	363	510
Total UILW	191,000	106,000	256,000	323,000
NB UILW				
3 m^3 box	961	961	2,550	3,140
3 m^3 drum	7,270	7,270	16,200	19,000
Total NB UILW	8,230	8,230	18,800	22,100
NB SILW				
4m box (100 mm concrete)	60	60	858	1,200
1 m^3 concrete drum (0 mm steel)	1,800	1,800	1,590	3,600
1 m^3 concrete drum (40 mm steel)	2,880	2,880	1,790	5,760
1 m^3 concrete drum (70mm steel)	2,160	2,160	1,100	4,320
500 l concrete drum (40mm steel)	3,240	3,240	942	4,000
Total NB SILW	10,100	3,150	6,280	18,900
DNLEU				

Waste container	No. packages	No. Disposal Units	Conditioned Volume (m^3)	Packaged Volume (m^3)
500 l drum (DNLEU)	23,800	5,900	11,200	13,600
TDC (2.1m ht)	464	464	8,710	11,790
TDC (2.3m ht)	3,780	3,780	75,000	105,000
TDC (2.4m ht)	2,890	2,890	63,300	83,800
Total DNLEU	31,000	13,100	158,000	214,000
DCIC				
DCIC Type VI	1,040	1,040	2,920	5,650
DCIC Type II (0 mm Pb)	683	683	335	901
DCIC Type II (20 mm Pb)	370	370	149	488
DCIC Type II (30 mm Pb)	146	146	54.3	193
DCIC Type II (60 mm Pb)	2	2	0.444	2.02
DCIC Type II (80 mm Pb)	1	1	$6.68\ 10^{-2}$	0.362
DCIC Type II (90 mm Pb)	6	6	1.14	6.80
DCIC Type II (120 mm Pb)	28	28	4.56	36.2
Total DCIC	2,280	2,280	3,460	7,280
HLW				
HLW Disposal Container	2,310	2,310	1,360	8,930
Legacy SF				
AGR SF Disposal Container	2,190	2,190	1,930	9,160
Magnox SF Disposal Container	4,220	4,220	5,050	17,200
PFR SF Disposal Container	19	19	10.9	48.7
PWR SF Disposal Container	572	572	425	2,160
Total Legacy SF	7,000	7,000	7,420	28,600
NB SF				
NB SF Disposal Container	8,940	8,940	5,890	39,400
MOX SF				
MOX SF Disposal Container	2,530	2,530	556	11,200
HEU				
HEU / Pu Disposal Container	780	780	694	2,470
Pu				
HEU / Pu Disposal Container	196	196	174	620

Table B26 Scenario 3: waste packages, disposal units, conditioned volumes and packaged volumes, presented by waste group.

Waste container	No. packages	No. Disposal Units	Conditioned Volume (m^3)	Packaged Volume (m^3)
SILW / SLLW				
2m box (100 mm concrete)	75	75	334	758
4m box (0 mm concrete)	2,760	2,760	52,100	55,300
4m box (100 mm concrete)	1,200	1,200	17,100	23,900
4m box (200 mm concrete)	408	408	4,440	8,150
6 m^3 box (High density)	96	96	544	1,130
6 m^3 box (Standard density)	330	330	1,900	3,910
Total SILW	4,870	4,870	79,600	93,100
UILW / ULLW				
3 m^3 box (round corners)	4,910	4,910	13,100	16,100
3 m^3 box (square corners)	403	403	1,120	1,450
3 m^3 drum	635	635	1,420	1,660
3 m^3 Sellafield box	54,300	54,300	147,000	179,000
3 m^3 Enhanced Sellafield box	16,300	16,300	35,100	53,900
500 l drum	92,000	23,000	42,900	52,600
MBGWS box	1,500	1,500	5,270	7,070
Enhanced 500 l drum (basket)	26,100	6,520	13,200	14,900
Enhanced 500 l drum (pre-cast)	893	223	363	510
Total UILW	197,000	108,000	269,000	327,000
NB UILW				
3 m^3 box	961	961	2,550	3,140
3 m^3 drum	7,270	7,270	16,200	19,000
Total NB UILW	8,230	8,230	18,800	22,100
NB SILW				
4m box (100 mm concrete)	60	60	858	1,200
1 m^3 concrete drum (0 mm steel)	1,800	1,800	1,590	3,600
1 m^3 concrete drum (40 mm steel)	2,880	2,880	1,790	5,760
1 m^3 concrete drum (70mm steel)	2,160	2,160	1,100	4,320
500 l concrete drum (40mm steel)	3,240	3,240	942	4,000
Total NB SILW	10,100	3,150	6,280	18,900
DNLEU				
500 l drum (DNLEU)	23,800	5,950	11,200	13,600

Waste container	No. packages	No. Disposal Units	Conditioned Volume (m^3)	Packaged Volume (m^3)
TDC (2.1m ht)	581	581	10,900	14,800
TDC (2.3m ht)	3,780	3,780	75,000	105,000
TDC (2.4m ht)	2,890	2,890	63,300	83,800
Total DNLEU	31,000	13,200	160,000	217,000
DCIC				
DCIC Type VI	1,040	1,040	2,920	5,650
DCIC Type II (0 mm Pb)	758	758	371	999
DCIC Type II (20 mm Pb)	370	370	149	488
DCIC Type II (30 mm Pb)	146	146	54.3	193
DCIC Type II (60 mm Pb)	2	2	0.444	2.02
DCIC Type II (80 mm Pb)	1	1	$6.68\ 10^{-2}$	0.362
DCIC Type II (90 mm Pb)	6	6	1.14	6.80
DCIC Type II (120 mm Pb)	28	28	4.56	36.2
Total DCIC	2,350	2,350	3,500	7,380
HLW				
HLW Disposal Container	2,400	2,400	1,410	9,290
Legacy SF				
AGR SF Disposal Container	3,040	3,040	2,690	12,800
Magnox SF Disposal Container	836	836	999	3,390
PFR SF Disposal Container	19	19	10.9	48.7
PWR SF Disposal Container	869	869	646	3,280
Total Legacy SF	4,760	4,760	4,350	19,500
NB SF				
NB SF Disposal Container	8,940	8,940	5,890	39,400
MOX SF				
MOX SF Disposal Container	2,710	2,710	594	11,900
HEU				
HEU / Pu Disposal Container	780	780	694	2,470
Pu				
HEU / Pu Disposal Container	196	196	174	620

Table B27 Scenario 4a: waste packages, disposal units, conditioned volumes and packaged volumes, presented by waste group.

Waste container	No. packages	No. Disposal Units	Conditioned Volume (m^3)	Packaged Volume (m^3)
SILW / SLLW				
2m box (100 mm concrete)	38	38	167	379
4m box (0 mm concrete)	2,220	2,220	38,100	44,400
4m box (100 mm concrete)	836	836	11,900	16,700
4m box (200 mm concrete)	311	311	3,390	6,230
6 m^3 box (High density)	81	81	463	960
6 m^3 box (Standard density)	260	260	1,500	3,080
Total SILW	3,750	3,750	61,800	71,700
UILW / ULLW				
3 m^3 box (round corners)	3,400	3,400	9,050	11,100
3 m^3 box (square corners)	318	318	889	1,150
3 m^3 drum	408	408	914	1,060
3 m^3 Sellafield box	38,300	38,300	104,000	126,000
3 m^3 Enhanced Sellafield box	15,800	15,800	33,900	52,100
500 l drum	80,500	20,100	41,300	51,500
MBGWS box	1,340	1,340	4,700	6,310
Enhanced 500 l drum (basket)	21,000	5,250	10,600	12,000
Enhanced 500 l drum (pre-cast)	802	201	326	458
Total UILW	162,000	85,100	216,000	262,000
NB UILW				
3 m^3 box	961	961	2,550	3,140
3 m^3 drum	7,270	7,270	16,200	19,000
Total NB UILW	8,230	8,230	18,800	22,100
NB SILW				
4m box (100 mm concrete)	60	60	858	1,200
1 m^3 concrete drum (0 mm steel)	1,800	1,800	1,590	3,600
1 m^3 concrete drum (40 mm steel)	2,880	2,880	1,790	5,760
1 m^3 concrete drum (70mm steel)	2,160	2,160	1,100	4,320
500 l concrete drum (40mm steel)	3,240	3,240	942	4,000
Total NB SILW	10,100	3,150	6,280	18,900
DNLEU				
500 l drum (DNLEU)	23,800	5,950	11,200	13,600

Waste container	No. packages	No. Disposal Units	Conditioned Volume (m^3)	Packaged Volume (m^3)
TDC (2.1m ht)	581	581	10,900	14,800
TDC (2.3m ht)	3,780	3,780	75,000	105,000
TDC (2.4m ht)	2,890	2,890	63,300	83,800
Total DNLEU	31,000	13,200	160,000	217,000
DCIC				
DCIC Type VI	877	877	2,460	4,770
DCIC Type II (0 mm Pb)	579	579	284	764
DCIC Type II (20 mm Pb)	340	340	137	448
DCIC Type II (30 mm Pb)	141	141	52.1	185
DCIC Type II (60 mm Pb)	2	2	0.355	1.61
DCIC Type II (80 mm Pb)	1	1	$5.35\ 10^{-2}$	0.289
DCIC Type II (90 mm Pb)	5	5	1.09	6.46
DCIC Type II (120 mm Pb)	25	25	4.05	32.2
Total DCIC	1,970	1,970	2,940	6,210
HLW				
HLW Disposal Container	1,860	1,860	1,100	7,210
Legacy SF				
AGR SF Disposal Container	2,190	2,190	1,930	9,160
Magnox SF Disposal Container	836	836	999	3,390
PFR SF Disposal Container	19	19	10.9	48.7
PWR SF Disposal Container	572	572	425	2,160
Total Legacy SF	3,620	3,620	3,360	14,800
NB SF				
NB SF Disposal Container	8,940	8,940	5,890	39,400
MOX SF				
MOX SF Disposal Container	2,710	2,710	594	11,900
HEU				
HEU / Pu Disposal Container	780	780	694	2,470
Pu				
HEU / Pu Disposal Container	196	196	174	620

Table B28 Scenario 4b: waste packages, disposal units, conditioned volumes and packaged volumes, presented by waste group.

Waste container	No. packages	No. Disposal Units	Conditioned Volume (m^3)	Packaged Volume (m^3)
SILW / SLLW				
2m box (100 mm concrete)	112	112	500	1,140
4m box (0 mm concrete)	4,580	4,580	79,300	91,700
4m box (100 mm concrete)	1,570	1,570	22,400	31,400
4m box (200 mm concrete)	488	488	5,310	9,750
6 m^3 box (High density)	110	110	626	1,300
6 m^3 box (Standard density)	384	384	2,210	4,540
Total SILW	7,240	7,240	123,000	140,000
UILW / ULLW				
3 m^3 box (round corners)	6,010	6,010	16,000	19,700
3 m^3 box (square corners)	744	744	2,080	2,680
3 m^3 drum	729	729	1,630	1,900
3 m^3 Sellafield box	138,000	138,000	372,000	454,000
3 m^3 Enhanced Sellafield box	23,700	23,700	51,000	78,300
500 l drum	116,000	29,000	59,700	73,100
MBGWS box	1,670	1,670	5,840	7,840
Enhanced 500 l drum (basket)	36,100	9,020	18,200	20,600
Enhanced 500 l drum (pre-cast)	985	246	399	562
Total UILW	324,000	209,000	540,000	659,000
NB UILW				
3 m^3 box	961	961	2,550	3,140
3 m^3 drum	7,270	7,270	16,200	19,000
Total NB UILW	8,230	8,230	18,800	22,100
NB SILW				
4m box (100 mm concrete)	60	60	858	1,200
1 m^3 concrete drum (0 mm steel)	1,800	1,800	1,590	3,600
1 m^3 concrete drum (40 mm steel)	2,880	2,880	1,790	5,760
1 m^3 concrete drum (70mm steel)	2,160	2,160	1,100	4,320
500 l concrete drum (40mm steel)	3,240	3,240	942	4,000
Total NB SILW	10,100	3,150	6,280	18,900
DNLEU				
500 l drum (DNLEU)	23,800	5,950	11,200	13,600

Waste container	No. packages	No. Disposal Units	Conditioned Volume (m^3)	Packaged Volume (m^3)
TDC (2.1m ht)	581	581	10,900	14,800
TDC (2.3m ht)	3,780	3,780	75,000	105,000
TDC (2.4m ht)	2,890	2,890	63,300	83,800
Total DNLEU	31,000	13,200	160,000	217,000
DCIC				
DCIC Type VI	1,230	1,230	3,460	6,710
DCIC Type II (0 mm Pb)	792	792	388	1,040
DCIC Type II (20 mm Pb)	412	412	166	544
DCIC Type II (30 mm Pb)	164	164	60.7	215
DCIC Type II (60 mm Pb)	2	2	0.533	2.42
DCIC Type II (80 mm Pb)	1	1	$8.02\ 10^{-2}$	0.434
DCIC Type II (90 mm Pb)	6	6	1.20	7.14
DCIC Type II (120 mm Pb)	31	31	5.07	40.3
Total DCIC	2,640	2,640	4,080	8,560
HLW				
HLW Disposal Container	5,640	5,640	3,320	21,800
Legacy SF				
AGR SF Disposal Container	2,190	2,190	1,930	9,160
Magnox SF Disposal Container	836	836	999	3,390
PFR SF Disposal Container	19	19	10.9	48.7
PWR SF Disposal Container	572	572	425	2,160
Total Legacy SF	3,620	3,620	3,360	14,800
NB SF				
NB SF Disposal Container	8,940	8,940	5,890	39,400
MOX SF				
MOX SF Disposal Container	2,710	2,710	594	11,900
HEU				
HEU / Pu Disposal Container	780	780	694	2,470
Pu				
HEU / Pu Disposal Container	196	196	174	620

Table B29 Scenario 8: waste packages, disposal units, conditioned volumes and packaged volumes, presented by waste group for a single UK EPR.

Waste container	No. packages	No. Disposal Units	Conditioned Volume (m^3)	Packaged Volume (m^3)
NB UILW				
3 m³ box	71	71	189	232
NB SILW				
4m box (100 mm concrete)	10	10	143	200
1 m^3 concrete drum (0 mm steel)	300	300	265	600
1 m^3 concrete drum (40 mm steel)	480	480	298	961
1 m^3 concrete drum (70mm steel)	360	360	183	720
500 l concrete drum (40mm steel)	540	540	157	667
Total NB SILW	1,690	525	1,050	3,150
NB SF				
NB SF Disposal Container	871	871	573	3,840

Table B30 Scenario 8: waste packages, disposal units, conditioned volumes and packaged volumes, presented by waste group for a single AP1000

Waste container	No. packages	No. Disposal Units	Conditioned Volume (m^3)	Packaged Volume (m^3)
NB UILW				
3 m³ box	90	90	237	292
3 m³ drum	1,210	1,210	2,700	3,160
Total NB UILW	1,300	1,300	2,940	3,450
NB SF				
NB SF Disposal Container	621	621	408	2,730

Table B31 Scenario 8: waste packages, disposal units, conditioned[43] volumes and packaged volumes, presented by waste group for a single UK ABWR

Waste container	No. packages	No. Disposal Units	Conditioned Volume (m^3)	Packaged Volume (m^3)
NB UILW				
3 m^3 box	147	147	391	481
3 m^3 drum	531	531	1180	1385
Total NB UILW	678	678	1580	1870
NB SILW				
4 m box	39	39	736	781

[43] The PCSR report does not specify whether there is any additional concrete shielding used in the 4 m box. When calculating the conditioned volume, it has been assumed that there is no additional concrete shielding.

Table B32 Scenario 11: waste packages, disposal units, conditioned volumes and packaged volumes, presented by waste group

Waste container	No. packages	No. Disposal Units	Conditioned Volume (m^3)	Packaged Volume (m^3)
SILW / SLLW				
2m box (100 mm concrete)	75	75	334	758
4m box (0 mm concrete)	391	391	7,370	7,810
4m box (100 mm concrete)	281	281	4,020	5,630
4m box (200 mm concrete)	399	399	4,350	7,990
6 m^3 box (High density)	96	96	544	1,130
6 m^3 box (Standard density)	199	199	1,140	2,350
Total SILW	1,440	1,440	18,200	25,700
UILW / ULLW				
3 m^3 box (round corners)	4,770	4,770	12,700	15,600
3 m^3 box (square corners)	403	403	1,120	1,450
3 m^3 drum	563	563	1,260	1,470
3 m^3 Sellafield box	49,700	49,700	134,000	164,000
3 m^3 Enhanced Sellafield box	16,300	16,300	35,100	53,900
500 l drum	73,800	18,400	36,200	42,100
MBGWS box	1,500	1,500	5,270	7,070
Enhanced 500 l drum (basket)	26,100	6,520	13,200	14,900
Enhanced 500 l drum (pre-cast)	893	223	363	510
Total UILW	174,000	98,400	245,000	301,000
NB UILW				
3 m^3 box	961	961	2,550	3,140
3 m^3 drum	7,270	7,270	16,200	19,000
Total NB UILW	8,230	8,230	18,800	22,100
NB SILW				
4m box (100 mm concrete)	60	60	858	1,200
1 m^3 concrete drum (0 mm steel)	1,800	1,800	1,590	3,600
1 m^3 concrete drum (40 mm steel)	2,880	2,880	1,790	5,760
1 m^3 concrete drum (70mm steel)	2,160	2,160	1,100	4,320
500 l concrete drum (40mm steel)	3,240	3,240	942	4,000
Total NB SILW	10,100	3,150	6,280	18,900
DNLEU				
500 l drum (DNLEU)	23,800	5,950	11,200	13,600

Waste container	No. packages	No. Disposal Units	Conditioned Volume (m^3)	Packaged Volume (m^3)
TDC (2.1m ht)	581	581	10,900	14,800
TDC (2.3m ht)	3,780	3,780	75,000	105,000
TDC (2.4m ht)	2,890	2,890	63,300	83,800
Total DNLEU	31,000	13,200	160,000	217,000
DCIC				
DCIC Type VI	1,040	1,040	2,920	5,650
DCIC Type II (0 mm Pb)	683	683	335	901
DCIC Type II (20 mm Pb)	370	370	149	488
DCIC Type II (30 mm Pb)	146	146	54.3	193
DCIC Type II (60 mm Pb)	2	2	0.444	2.02
DCIC Type II (80 mm Pb)	1	1	6.68 10-2	0.362
DCIC Type II (90 mm Pb)	6	6	1.14	6.80
DCIC Type II (120 mm Pb)	28	28	4.56	36.2
Total DCIC	2,280	2,280	3,460	7,280
HLW				
HLW Disposal Container	2,400	2,400	1,410	9,290
Legacy SF				
AGR SF Disposal Container	2,190	2,190	1,930	9,160
Magnox SF Disposal Container	836	836	999	3,390
PFR SF Disposal Container	19	19	10.9	48.7
PWR SF Disposal Container	572	572	425	2,160
Total Legacy SF	3,620	3,620	3,360	14,800
NB SF				
NB SF Disposal Container	8,940	8,940	5,890	39,400
MOX SF				
MOX SF Disposal Container	2,710	2,710	594	11,900
HEU				
HEU / Pu Disposal Container	780	780	694	2,470
Pu				
HEU / Pu Disposal Container	196	196	174	620

Table B33 Scenario 12: waste packages, disposal units, conditioned volumes and packaged volumes, presented by waste group

Waste container	No. packages	No. Disposal Units	Conditioned Volume (m^3)	Packaged Volume (m^3)
SILW / SLLW				
2m box (100 mm concrete)	75	75	334	758
4m box (0 mm concrete)	2,750	2,750	52,000	55,100
4m box (100 mm concrete)	1,190	1,190	17,100	23,900
4m box (200 mm concrete)	399	399	4,350	7,990
6 m^3 box (High density)	96	96	544	1,130
6 m^3 box (Standard density)	330	330	1,900	3,910
Total SILW	4,840	4,840	79,300	92,800
UILW / ULLW				
3 m^3 box (round corners)	2,650	2,650	7,040	8,660
3 m^3 box (square corners)	403	403	1,120	1,450
3 m^3 drum	48	48	113	124
3 m^3 Sellafield box	54,300	54,300	147,000	179,000
3 m^3 Enhanced Sellafield box	16,300	16,300	35,100	53,900
500 l drum	91,700	22,900	42,700	52,300
MBGWS box	1,500	1,500	5,270	7,070
Enhanced 500 l drum (basket)	26,100	6,520	13,200	14,900
Enhanced 500 l drum (pre-cast)	893	223	363	510
Total UILW	194,000	105,000	262,000	318,000
NB UILW				
3 m^3 box	961	961	2,550	3,140
3 m^3 drum	7,270	7,270	16,200	19,000
Total NB UILW	8,230	8,230	18,800	22,100
NB SILW				
4m box (100 mm concrete)	60	60	858	1,200
1 m^3 concrete drum (0 mm steel)	1,800	1,800	1,590	3,600
1 m^3 concrete drum (40 mm steel)	2,880	2,880	1,790	5,760
1 m^3 concrete drum (70mm steel)	2,160	2,160	1,100	4,320
500 l concrete drum (40mm steel)	3,240	3,240	942	4,000
Total NB SILW	10,100	3,150	6,280	18,900
DNLEU				
500 l drum (DNLEU)	23,800	5,950	11,200	13,600

Waste container	No. packages	No. Disposal Units	Conditioned Volume (m³)	Packaged Volume (m³)
TDC (2.1m ht)	581	581	10,900	14,800
TDC (2.3m ht)	3,780	3,780	75,000	105,000
TDC (2.4m ht)	2,890	2,890	63,300	83,800
Total DNLEU	31,000	13,200	160,000	217,000
DCIC				
DCIC Type VI	950	950	2,690	5,160
DCIC Type II (0 mm Pb)	683	683	335	901
DCIC Type II (20 mm Pb)	370	370	149	488
DCIC Type II (30 mm Pb)	146	146	54.3	193
DCIC Type II (60 mm Pb)	2	2	0.444	2.02
DCIC Type II (80 mm Pb)	1	1	6.68 10-2	0.362
DCIC Type II (90 mm Pb)	6	6	1.14	6.80
DCIC Type II (120 mm Pb)	28	28	4.56	36.2
Total DCIC	2,190	2,190	3,230	6,790
HLW				
HLW Disposal Container	2,400	2,400	1,410	9,290
Legacy SF				
AGR SF Disposal Container	2,190	2,190	1,930	9,160
Magnox SF Disposal Container	836	836	999	3,390
PFR SF Disposal Container	19	19	10.9	48.7
PWR SF Disposal Container	572	572	425	2,160
Total Legacy SF	3,620	3,620	3,360	14,800
NB SF				
NB SF Disposal Container	8,940	8,940	5,890	39,400
MOX SF				
MOX SF Disposal Container	2,710	2,710	594	11,900
HEU				
HEU / Pu Disposal Container	780	780	694	2,470
Pu				
HEU / Pu Disposal Container	196	196	174	620

B3 Radionuclide activity at 2200 for priority 1 radionuclides

Table B34 The activities of the priority 1 radionuclides at 2200 for those waste groups affected in Scenario 2

Radio-nuclide	ULLW / UILW	HLW	Legacy SF	MOX SF	DNLEU
C14	1,340	0	1,100	219	$6.24\ 10^{-10}$
Cl36	9.37	1.28	3.31	1.244	0
Co60	$2.69\ 10^{-3}$	$2.71\ 10^{-7}$	$1.32\ 10^{-4}$	$1.77\ 10^{-2}$	$8.11\ 10^{-30}$
Se79	0.376	16.0	13.7	4.00	$1.67\ 10^{-9}$
Kr85	$25.3\ 10^{-2}$	0	15.0	38.8	0
Tc99	809	2,410	2,150	973	0.606
I129	0.600	$8.41\ 10^{-2}$	7.50	3.07	$1.50\ 10^{-9}$
Cs135	7.51	174	142	78.4	$2.28\ 10^{-8}$
Cs137	7,800	250,000	356,000	292,000	$4.59\ 10^{-5}$
U233	1.14	$3.09\ 10^{-2}$	0.676	0.298	$1.49\ 10^{-3}$
U235	0.583	$9.49\ 10^{-4}$	3.84	0.138	41.2
U238	18.2	$2.49\ 10^{-2}$	111	15.0	2,250
Np237	105	43.5	84.1	82.6	$1.66\ 10^{-2}$

Table B35 The activities of the priority 1 radionuclides at 2200 for those waste groups affected in Scenario 3

Radio-nuclide	ULLW / UILW	SLLW / SILW	RSCs	Legacy SF
C14	1,360	6,400	8.74	1,040
Cl36	9.51	26.0	0.446	4.44
Co60	$1.06\ 10^{-2}$	$1.68\ 10^{-5}$	$6.58\ 10^{-8}$	$1.42\ 10^{-3}$
Se79	0.387	$3.30\ 10^{-4}$	$1.40\ 10^{-4}$	19.4
Kr85	$2.53\ 10^{-2}$	$2.53\ 10^{-5}$	$2.79\ 10^{-5}$	33.6
Tc99	917	0.301	$8.06\ 10^{-2}$	2,580
I129	0.621	$2.06\ 10^{-5}$	$4.66\ 10^{-4}$	9.51
Cs135	7.64	$4.81\ 10^{-2}$	$7.82\ 10^{-3}$	185
Cs137	8,140	3.75	21.5	531,000
U233	1.14	$5.96\ 10^{-2}$	$1.80\ 10^{-4}$	0.658
U235	0.591	$1.91\ 10^{-4}$	$5.21\ 10^{-4}$	4.50
U238	18.6	$2.99\ 10^{-3}$	$3.94\ 10^{-2}$	101
Np237	110	$2.87\ 10^{-2}$	$1.49\ 10^{-2}$	109

Table B36 The activities of the priority 1 radionuclides at 2200 for those waste groups affected in Scenario 4

Radio-nuclide	ULLW / UILW		SLLW / SILW		RSCs		HLW	
	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower
C14	51,900	287	58,500	856	102	0.646	-	-
Cl36	93.9	2.86	263	2.66	5.82	$3.90\ 10^{-2}$	2.37	0.83
Co60	0.321	$2.84\ 10^{-5}$	$2.16\ 10^{-4}$	$5.79\ 10^{-7}$	$1.66\ 10^{-7}$	$1.70\ 10^{-9}$	$4.49\ 10^{-7}$	$1.99\ 10^{-7}$
Se79	0.986	0.183	$1.32\ 10^{-3}$	$9.91\ 10^{-5}$	$1.41\ 10^{-3}$	$1.37\ 10^{-5}$	25.1	11.1
Kr85	$4.64\ 10^{-2}$	$1.49\ 10^{-2}$	$7.55\ 10^{-5}$	$8.42\ 10^{-6}$	$6.58\ 10^{-5}$	$6.59\ 10^{-7}$	-	-
Tc99	7,630	374	2.14	$3.22\ 10^{-2}$	0.462	$6.32\ 10^{-3}$	3,700	1,640
I129	2.90	0.186	$1.47\ 10^{-4}$	$2.13\ 10^{-6}$	$1.29\ 10^{-2}$	$2.72\ 10^{-5}$	0.132	$5.85\ 10^{-2}$
Cs135	21.2	3.05	0.173	$1.51\ 10^{-2}$	$7.77\ 10^{-2}$	$7.62\ 10^{-4}$	274	122
Cs137	23,000	3,270	34.8	0.524	231	2.65	402,000	174,000
U233	3.93	0.287	0.197	$1.92\ 10^{-2}$	$1.60\ 10^{-3}$	$1.75\ 10^{-5}$	$4.71\ 10^{-2}$	$2.09\ 10^{-2}$
U235	2.36	0.261	$1.78\ 10^{-3}$	$1.95\ 10^{-5}$	$5.52\ 10^{-3}$	$5.12\ 10^{-5}$	1.47E-03	$6.54\ 10^{-4}$
U238	62.0	8.91	$2.98\ 10^{-2}$	$3.01\ 10^{-4}$	0.51	$3.83\ 10^{-3}$	$3.91\ 10^{-2}$	$1.74\ 10^{-2}$
Np237	662	25.8	0.285	$2.91\ 10^{-3}$	$5.19\ 10^{-2}$	$9.76\ 10^{-4}$	66.4	29.5

Table B37 The activities of the priority 1 radionuclides at 2200 for those waste groups affected in Scenario 11

Radio-nuclide	ULLW / UILW	SLLW / SILW
C14	616	207
Cl36	7.90	0.456
Co60	$2.69\ 10^{-3}$	$5.95\ 10^{-6}$
Se79	0.387	$3.30\ 10^{-4}$
Kr85	$2.52\ 10^{-2}$	$2.53\ 10^{-5}$
Tc99	917	0.282
I129	0.621	$2.06\ 10^{-5}$
Cs135	7.63	$4.81\ 10^{-2}$
Cs137	8,120	3.75
U233	1.08	$5.96\ 10^{-2}$
U235	0.591	$1.91\ 10^{-4}$
U238	18.6	$2.99\ 10^{-3}$
Np237	110	$2.87\ 10^{-2}$

Table B38 The activities of the priority 1 radionuclides at 2200 for those waste groups affected in Scenario 12

Radio-nuclide	Legacy ULLW / UILW	Legacy SLLW / SILW	RSCs
C14	1,330	6,400	7.41
Cl36	9.29	26.0	0.434
Co60	$2.69\ 10^{-3}$	$7.69\ 10^{-6}$	$1.74\ 10^{-8}$
Se79	0.387	$3.30\ 10^{-4}$	$1.39\ 10^{-4}$
Kr85	$2.53\ 10^{-2}$	$2.53\ 10^{-5}$	$6.60\ 10^{-6}$
Tc99	917	0.301	$7.82\ 10^{-2}$
I129	0.621	$2.06\ 10^{-5}$	$4.57\ 10^{-4}$
Cs135	7.64	$4.81\ 10^{-2}$	$7.73\ 10^{-3}$
Cs137	8,110	3.75	21.1
U233	1.14	$5.96\ 10^{-2}$	$1.80\ 10^{-4}$
U235	0.585	$1.91\ 10^{-4}$	$5.20\ 10^{-4}$
U238	18.4	$2.98\ 10^{-3}$	$3.93\ 10^{-2}$
Np237	110	$2.87\ 10^{-2}$	$1.47\ 10^{-2}$

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