Nuclear Waste Services

2022 Inventory for Geological Disposal

Main Report

July 2025

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Contents

Introduction

The generic Disposal System Safety Case

Nuclear Waste Services (NWS) (formerly Radioactive Waste Management Ltd) is the organisation responsible for delivering a programme for the safe, secure and permanent geological disposal of the UK's most hazardous radioactive wastes. Information on the approach of the UK Government and devolved administrations of Wales and Northern Ireland[1] to implementing geological disposal is included in an overview of the generic Disposal System Safety Case (DSSC) [1].

A geological disposal facility (GDF) will be a highly engineered facility, located deep underground, where the waste will be isolated within a system of multiple engineered and natural barriers designed to prevent harmful quantities of radioactivity and non-radioactive contaminants from being released to the surface environment.

To identify potentially suitable sites for a GDF, the Government has developed an approach based on consent: working with interested communities that are willing to participate in the siting process [2]. No site has yet been identified for a GDF although several search areas are being investigated.

To make progress during the siting process, NWS 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 (HSR), for example, granite
- lower strength sedimentary rock (LSSR), for example, clay
- evaporite rock (EVR), for example, halite

The inventory for disposal in the GDF is defined in the UK policy framework for managing radioactive substances and nuclear decommissioning [2]. The inventory includes radioactive wastes and nuclear materials that could, potentially, be classified 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,

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[1] 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. In Scottish policy the term 'higher activity' radioactive waste refers to ILW and LLW which is not currently suitable for disposal in existing LLW facilities.

together with a small amount of low level waste (LLW) that is unsuitable for near-surface disposal, and stocks of depleted, natural and low enriched uranium (DNLEU)

NWS has developed six illustrative geological 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 concepts.

High-level information on 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 DSSC.

The generic DSSC plays a key role in the iterative development of a geological disposal system. This 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. These designs 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 demonstrates that geological disposal can be implemented safely and forms a benchmark for NWS to provide waste producers with advice on the packaging of waste for disposal. The suite of documents that make up the generic DSSC, and its high-level structure, are shown in Figure 1.

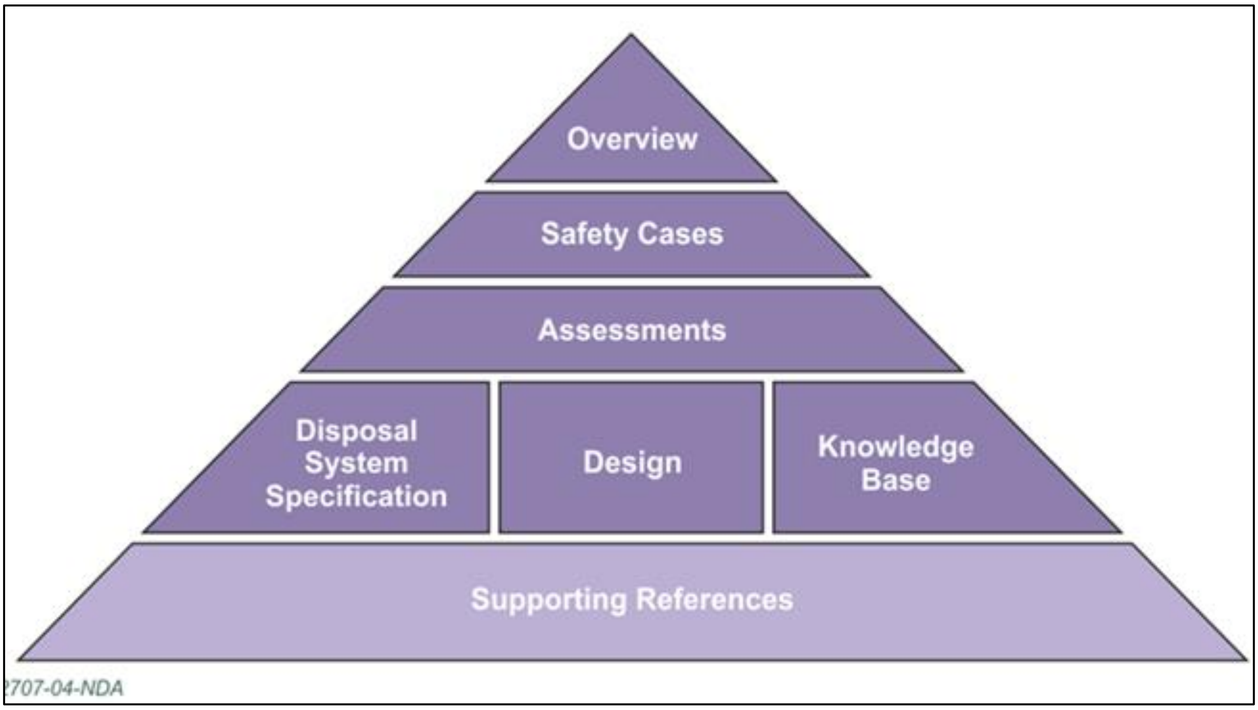

Figure 1 Structure of the generic DSSC.

The 2022 Inventory for Geological Disposal

Objectives of the Inventory for Geological Disposal

The objective of the inventory for geological disposal (IGD) is to provide information on the quantities and characteristics of the components of the inventory of waste destined for geological disposal that is sufficiently detailed for use in NWS' design and safety and environmental assessment work.

The information presented in the inventory includes the volumes, physical and chemical compositions, and activities of conditioned wastes and materials, and details of the containers in which they are assumed to be placed for disposal.

The 2022 IGD scenario was agreed in 2022 and the assumptions that have been made broadly reflect the policies, strategies and intentions at that point in time. However, these are all subject to change and the assumptions in the 2022 IGD may not reflect the current position.

Development of the IGD

The IGD is based on the UK Radioactive Waste and Materials Inventory (known as the UK Inventory or UK RWI). The process for producing the UK Inventory has been improved iteratively over many decades and is now well-established. Each UK Inventory contains details of stocks and projected arisings of all radioactive waste from existing sources (often called legacy wastes).

Currently, the UK Inventory is updated every three years, after which the IGD is updated, as shown in Figure 2. Waste in the UK Inventory dataset that will be managed through other routes (e.g. alternative disposal options and treatment routes) is discounted; the remaining data are reviewed and, where appropriate, enhanced[2]. The dataset is further enhanced to take account of Government policy and industry plans to produce the IGD. Finally, following the production of the UK Inventory (and IGD), the Nuclear Decommissioning Authority (NDA) and key users of the UK Inventory (including NWS) meet with waste producers to discuss key inventory improvements. In addition, further characterisation of wastes is carried out, leading to improvements in the inventory data. This iterative process drives continuous improvements in the UK Inventory data and, consequently, the IGD.

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[2] For the purposes of this work: 'review' is defined as the process of identifying omissions, differences, and inconsistencies within the 2022 UK Inventory itself, and with other sources of data; 'enhancement' is defined as the process of filling gaps and providing justified numeric and other data where these are not reported in the 2022 UK Inventory. For example, the UK Inventory only provides the mass of spent fuels; the enhancement process adds the radionuclide activities and materials and packaging assumptions.

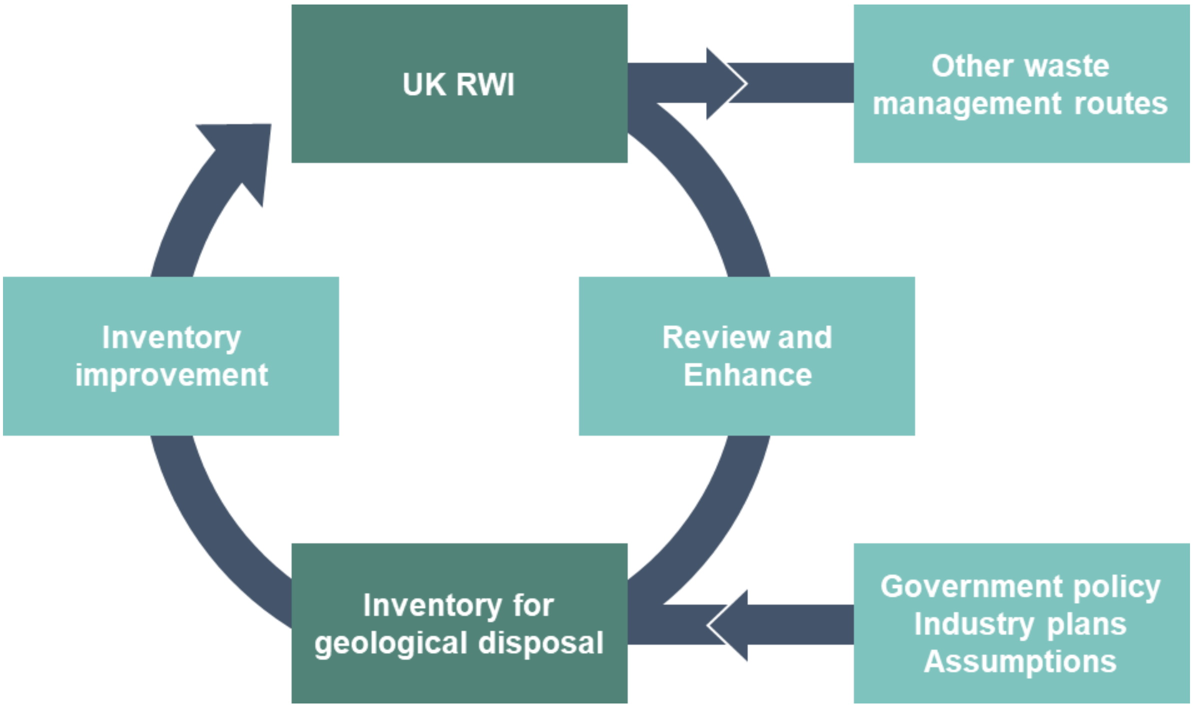

Figure 2 The iterative development of the inventory for geological disposal.

The IGD can also be updated in response to inventory data that becomes available between the current three-year cycle of the UK Inventory. Information may become available from several sources, for example from work ongoing within NWS or waste producing organisations.

Scope

Scope of the 2022 Inventory for Geological Disposal

The waste and material types that comprise the IGD are defined in paragraph 8.63 of the UK policy framework for managing radioactive substances and nuclear decommissioning [2]:

> The specific types of higher activity radioactive waste (and nuclear materials that could be declared as waste) which would comprise the inventory for disposal in a GDF are:
>
> - HLW arising from the reprocessed spent nuclear fuel at Sellafield;
> - ILW arising from existing nuclear licensed sites, defence, medical, industrial, research and educational facilities that is not suitable for disposal in near surface facilities;
> - the small proportion of LLW that is not suitable for disposal in near surface facilities;
> - spent fuel from existing commercial reactors (yet to be declared waste) and from research reactors that is not reprocessed;
> - spent fuel (yet to be declared waste) from new nuclear projects (including small modular reactors);
> - spent fuel (yet to be declared waste) from advanced modular reactors if it is suitable for disposal in a GDF;
> - ILW from new nuclear projects not suitable for disposal in near surface facilities;
> - the plutonium inventory (yet to be declared waste) – either as spent fuel following reuse or in an immobilised form suitable for geological disposal;
> - uranium stocks – including that arising from enrichment and fuel fabrication activities and reprocessing activities (yet to be declared waste); and
> - irradiated fuel and nuclear materials (yet to be declared waste) from the UK defence programme.

Information on how the IGD is compiled can be found in the 'Underpinning Report' [4]. Updates to the IGD can be either

- a full update, which includes a rigorous examination of the entire UK Inventory dataset: the dataset is reviewed and, where appropriate enhanced. Parameters such as those required to support the gas pathway analysis are calculated and the assumptions that underpin the inventory are also reviewed.
- a light update, in which the full review and enhancement process is not carried out: where waste streams are unchanged, the enhancements from the previous inventory are carried over. In addition, some calculations (e.g. calculations of metal geometry to support the gas pathway analysis) are not carried out.

The 2022 IGD is a full update to the IGD.

Scope of this report

This report presents detailed technical information and is targeted at an audience of scientists and engineers, in particular NWS staff and contractors who will use this information as a basis for generic geological disposal design and assessment work.

Reporting of the alternative inventory scenarios is also included within the scope of this report; however, the method by which the IGD is produced is not: this is covered in a separate report (the 'Underpinning Report' [4]).

Conventions

Waste Groups

NWS's generic disposal facility designs [5] recognise the different packaging and disposal processes for different types of radioactive waste: LLW, ILW and DNLEU are assumed to be disposed of in a LHGW area; HLW, spent fuels (SFs), plutonium and HEU are assumed to be disposed of in a HHGW area. The inventory for geological disposal has been broken down into waste groups (shown in light green boxes in Figure 3) that have been chosen to reflect the different sources of waste and how they will be disposed of in the GDF. The sources of waste considered are:

- legacy: wastes and materials that already exist or that will arise in the future as a result of the operation of existing nuclear facilities
- new build: wastes and spent fuels from the proposed new build programme
- mixed oxide (MOX): at this stage only spent fuel is included.

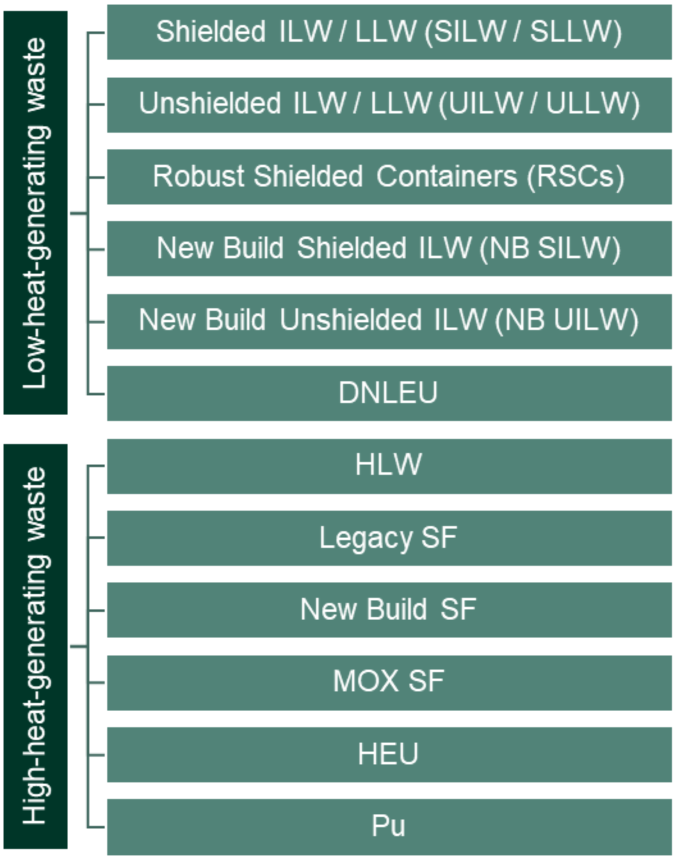

Figure 3 The two high-level partitions of the inventory (dark boxes) and the waste groups (light boxes).

Data

Summary data for the 2022 IGD are presented in Section 3, with a more detailed breakdown by waste group presented in *Appendix A: Waste Group Datasheets*.

The 2022 IGD presents data for:

- volumes: the stored, conditioned, and packaged volume of the inventory
- activities: information for 112 radionuclides identified as being relevant to geological disposal [6]. Data on selected 'priority' radionuclides[3] are presented along with the total activity from all 112 'relevant radionuclides' and their progeny
- the number of disposal units[4] associated with each type of package
- waste material masses: composition data on two levels: (i) the bulk materials that make up the wastes, and (ii) elemental composition of the wastes
- the properties of the inventory that are relevant to the gas pathway analysis.

All data are presented to three significant figures; this is considered to provide an appropriate quantification of the inventory data. In some cases the data are not available or are not specified to three significant figures. In these cases the data are presented to the level of precision to which they are known.

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[3] More detail on priority radionuclides is presented in the 'Underpinning Report' [4]

[4] A disposal unit is a waste package, or group of waste packages, which is handled as a single unit for the purposes of transport and disposal.

As a result of the rounding some tables will show totals that may not represent the sum of the rounded data that are presented within them. 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 the data.

The 2022 IGD reporting structure

The 2022 IGD reports

This document is the '2022 IGD Main Report' and is one of five reports that deal with the various aspects of the 2022 IGD; the full suite of reports comprises:

- The 'Main Report', which describes the key features of the IGD to a technical audience
- The 'Underpinning Report' [4], which describes how IGDs are developed and updated
- The 'Implications Report' [7], which describes the implications of the changes introduced by the 2022 IGD for the generic DSSC
- The 'Key Changes Report' [8], which sets out the differences between the 2022 IGD and the previous iteration (the 2019 IGD)
- The 'Summary' [9], which describes the key features of the report to a non-technical audience

Report structure

The remainder of this report is structured as follows:

- *Inventory scenarios* presents the reference and alternative inventory scenarios
- *The 2022 Inventory for Geological Disposal* presents a summary of the 2022 IGD
- *Uncertainty* discusses the uncertainty in the 2022 IGD
- *Summary of changes* presents an overview of the changes from the 2019 IGD
- *Summary and key messages* presents the key messages from the 2022 IGD

In addition, there are five appendices:

- *Appendix A: Waste Group Datasheets* provides datasheets for each of the waste groups
- *Appendix B: Alternative Scenarios* provides data for the alternative scenarios
- *Appendix C: Waste materials* presents information on the materials associated with the wastes, including the containers, and any conditioning and capping materials
- *Appendix D: Materials from GDF construction and operation* presents information on the materials associated with GDF construction and operation
- *Appendix E: Elemental compositions* presents information on the elemental composition of the inventory
- *Appendix F: Gas generation data* presents data relevant to gas pathway calculations

Inventory scenarios

The waste and material types that comprise the IGD are defined in the UK policy framework for managing radioactive substances and nuclear decommissioning. An inventory scenario describes how and when these waste and material types arise. The 2022 IGD considers three scenarios:

- a reference scenario that is based on Government policy, industry plans and other publicly available information; this represents NWS's best estimate of the waste that will arise
- two alternative scenarios that explore the effects of changes in assumptions that underpin the IGD

Summary of the Reference Scenario

The data for future waste arisings in the UK Inventory are projections made by the organisations that operate the sites where radioactive waste is generated. The projections are based on informed assumptions regarding the nature, scale and timing of future operations and activities. For the 2022 UK Inventory, these projections represent planning assumptions at 1 April 2022.The UK Inventory is the foundation of the scenario for the IGD but does not provide all the information that is required. As a result, several assumptions must be made to complete the IGD scenario; these are based on informed judgements.

The key assumptions are:

- quantities of legacy wastes and their time of arising are taken from the UK Inventory
- 24 GW(e) of new nuclear by 2050[5]
- 95% of the civil Pu (and all MOD Pu) is assumed to be converted to MOX fuel and irradiated in line with Government policy on the long-term management of plutonium at the IGD stock date[6] [10]
- radioactive wastes covered by the Scottish Government's policy for the management of higher activity radioactive waste [11] is excluded from the IGD
- The quantities of MOD materials are based on the Nuclear Liabilities Management Strategy [12]

Figure 4 provides a high-level overview of the timings of the different activities in the 2022 IGD reference scenario; full details are provided in Table 1, while Table 2 provides details of the scenario broken down by waste group. Full details of the 2022 IGD scenarios can be found in the 'Underpinning Report' [4].

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[5] Based on modelling assumptions and policy published under the previous government.

[6] Since the development of the IGD scenarios, the UK Government has taken the policy decision to immobilise the UK's inventory of civil separated plutonium at Sellafield [18].

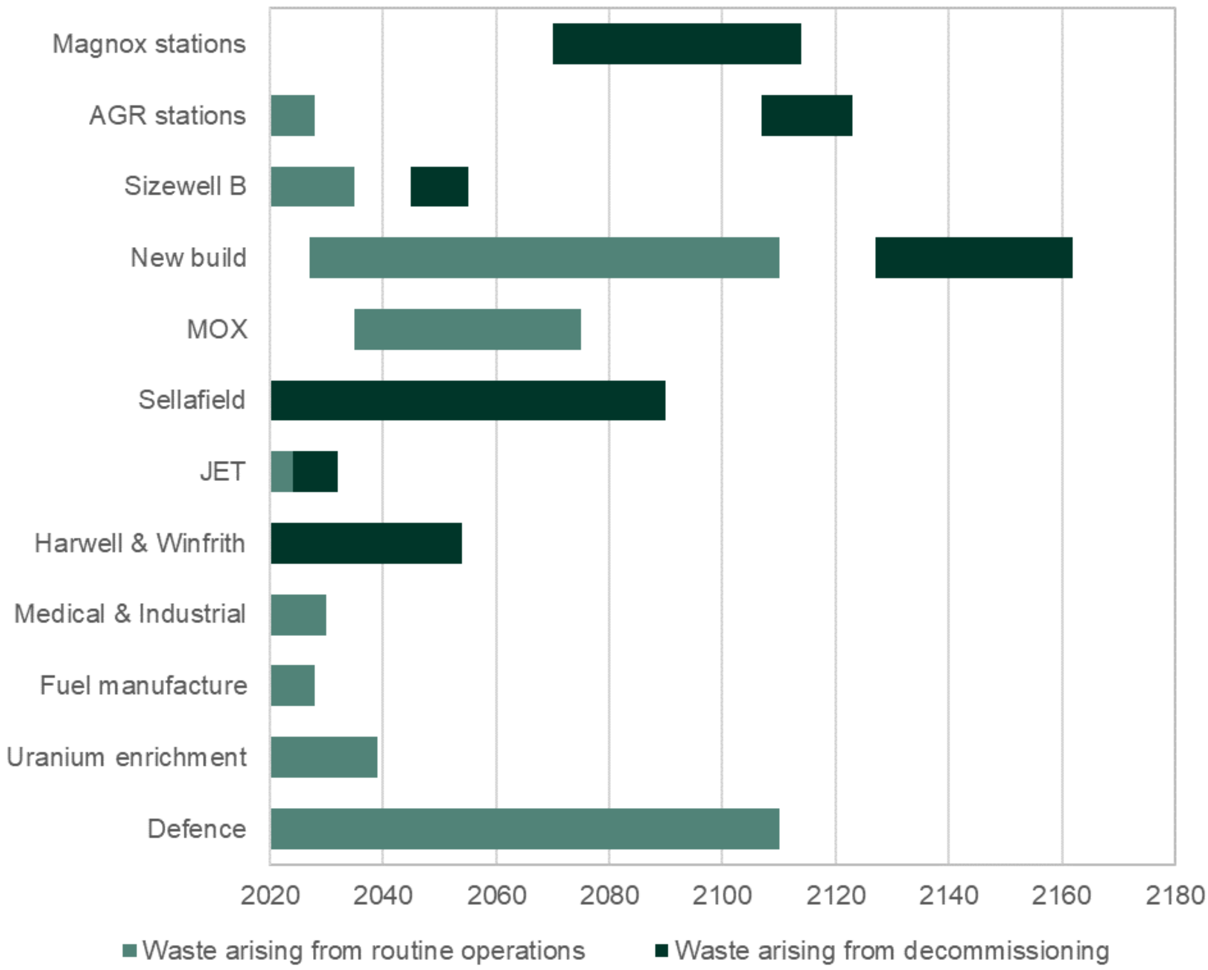

Figure 4 Assumed dates of operation and decommissioning for activities that contribute to the 2022 IGD[7].

[7] Decommissioning of the Magnox reprocessing plant and the thermal oxide reprocessing plant (THORP) are covered by Sellafield decommissioning. Magnox reprocessing completed operations in July 2022 and is not shown on this chart. No decommissioning dates have been specified for 'Fuel fabrication', 'Medical and industrial', 'Enrichment' or 'Defence' as there is either no decommissioning waste destined for a GDF arising or the waste producer has not included an estimate of the decommissioning waste in the UK Inventory. JET is the Joint European Torus.

Table 1 Timings and durations of activities in the 2022 IGD reference scenario

Sector	Assumptions[8]
Civil nuclear power stations	Sizewell B shuts down in 2035; prompt decommissioning (complete by 2053) AGRs: • Shuts down in 2022: Hinkley Point B, Hunterston B • Shuts down in 2024: Hartlepool, Heysham 1 • Shuts down in 2028: Heysham 2, Torness Deferral of Magnox and AGR final stage decommissioning for up to about 85 years after shutdown; all decommissioning complete by 2123 New build programme of 24 GW(e) comprising twin unit UK EPRs at Hinkley Point C and Sizewell C and 18 GW(e) of Small Modular Reactors (SMR) / Advance Modular Reactors (AMR). 60 years operation each; deferral of decommissioning until 40 years after reactor shutdown
Pu	95% of civil (and all Ministry of Defence (MOD)) Pu re-used as MOX fuel. 5% of civil Pu treated as waste MOX fuel is assumed to be irradiated from 2035 to 2075
U enrichment	Continues to 2039
Spent fuel reprocessing	Magnox reprocessing plant shutdown 2022 (55,000 tU in total) All reprocessing facilities fully decommissioned by 2090 289 tU Magnox SF is not reprocessed[9] 4,530 tU AGR SF is not reprocessed Sizewell B SF, New Build SF and MOX SF are not reprocessed
Research	The Joint European Torus (JET) operates until end of 2024
Harwell & Winfrith	All redundant facilities are fully decommissioned by 2054
Defence	A continuing nuclear defence capability (waste estimated to 2080) A continuing nuclear powered submarine programme (waste estimated to 2110)
Medical & industrial sources	The medical uses of radioactivity continue (arisings estimated to 2030)
Fuel fabrication	Continues until 2028 (although no operational or decommissioning waste destined for a GDF is produced through the manufacturing process)

[8] Excludes wastes managed under Scottish Government's Policy for higher activity radioactive waste [11].

[9] This represents the quantity of fuel that was not reprocessed at 01/04/22; Magnox reprocessing completed in July 2022.

Table 2 Estimated contents of each waste group in the 2022 IGD reference scenario

Waste Group	Assumptions[10]
SILW / SLLW UILW / ULLW RSCs	All 2022 UK Inventory ILW, excluding those wastes with an expected management strategy of incineration, recycling or disposal at the Low Level Waste Repository (LLWR) All 2022 UK Inventory LLW unsuitable for disposal at the LLWR
DNLEU	198,000 tU from civil fuel enrichment and civil spent fuel reprocessing 9,000 tU from defence programmes
NB SILW NB UILW	ILW from a 24 GW(e) nuclear new build programme
HLW	All 2022 UK Inventory HLW from reprocessing 55,000 tU Magnox SF and 5,000 tU Advanced gas-cooled reactor (AGR) SF

Legacy SF	SF to be managed by EDF:
	• 1,020 tU Sizewell B Pressurised Water Reactor (PWR) SF
	SF to be managed by NDA:
	• Oxide: 4,530 tU AGR SF
	• Magnox (assumed): 1,040 tU metallic SF
	• Exotic SF manged by NDA:
	  ○ 68.1 tU Steam Generating Heavy Water Reactor (SGHWR) SF
	  ○ 21.0 tU Windscale Advanced Gas-cooled Reactor (WAGR) SF
	  ○ 69.0 tU miscellaneous Light Water Reactor (LWR) SF
	  ○ 8.21 tHM Prototype Fast Reactor (PFR) SF
	Fuel not quantified:
	• Irradiated submarine fuel

NB SF	21,000 tU New Build SF
MOX SF	1,390 tHM MOX SF (includes fuel made from defence Pu) 8%wt Pu
HEU	1.0 tU from civil programmes
Pu	5.75 tHM separated Pu residues from reprocessing of civil SFs (representing 5% of the 115 tHM UK owned Pu unsuitable for re-use as MOX fuel)

[10] Excludes wastes managed under Scottish Government's Policy for higher activity radioactive waste [11].

Summary of the Alternative Scenarios

Alternative inventory scenarios are used to explore the effects of changes in assumptions on the IGD. Scenarios have been developed to define the 2022 IGD, these have been developed to be consistent with the inventory that will underpin the LLWR 2026 environmental safety case.

NWS has defined two alternative scenarios for the 2022 IGD:

- Scenario B
    - wastes and materials from the 2022 UK Inventory
    - 24 GW(e) of nuclear new build
    - the depleted uranium tails from the enrichment of fuel for the new build reactors
    - MOD materials
- Scenario C
    - wastes and materials from the 2022 UK Inventory
    - 16 GW(e) of nuclear new build
    - the exclusion of DNLEU
    - the exclusion of wastes potentially suitable for near-surface disposal
    - the thermal treatment of potentially suitable wastes
    - MOD materials.

Full descriptions of the scenarios can be found in the Underpinning Report [4].

Appendix B: Alternative Scenarios presents data sheets detailing the results for the alternative scenarios.

The 2022 Inventory for Geological Disposal

The inventory can be quantified in terms of several parameters; in this section the volume, disposal units, activity and materials composition of the 2022 IGD are presented.

This section presents summary information for the whole inventory, while *Appendix A: Waste Group Datasheets* presents a more detailed breakdown of the inventory data by the waste groups shown in Figure 3. The data presented are estimates based on the 2022 IGD scenario described in the *Summary of the Reference Scenario*.

It is noted that the data may differ from those presented in the UK RWI. There are several reasons for this:

- the UK RWI has subtly different conventions, e.g. packaged volumes represent the volume as packaged for long-term management (e.g. HLW in waste vitrification plant canisters), while the IGD reports the package volume for disposal (e.g. HLW in disposal containers)
- the scope of the IGD is different from that of the UK RWI, e.g. radioactive waste covered by the Scottish Government's policy for the management of higher activity radioactive waste [11] is excluded from the IGD
- the IGD review and enhancement process may introduce changes (see the Underpinning Report for further details [4]
- the IGD includes wastes and spent fuels from an assumed new build programme.

Volumes

Less than 10% of the stored volume of waste reported in the UK Inventory is destined for a GDF, as shown in Figure 5. Similarly, the wastes not reported in the UK Inventory but which are expected to come to a GDF, MOD materials and wastes from an assumed 24 GW(e) new build programme, are small in comparison to the total volumes of both the UK Inventory and the IGD. Table 3 presents the total stored, conditioned, and packaged volume of waste in the 2022 IGD reference scenario. The volume of waste (whether stored, conditioned, or packaged) is dominated by the LHGW: between them, the Legacy UILW / ULLW, DNLEU and Legacy SILW / SLLW contribute more than 80% of the packaged volume of the waste. Although LHGW accounts for most of the volume, it makes a small contribution to the activity at 2200 (see *Radioactivity*).

The ILW and spent fuel from the assumed new build programme contributes approximately 12% of the total packaged volume in the 2022 IGD (the *Uncertainty* section discusses the uncertainties associated with this).

Figure 6 shows the increase in the packaged volume[11] of the 2022 IGD with time, broken down into waste from existing facilities, waste from new build facilities, and MOX SF. All the waste is expected to have arisen by 2161.

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[11] This is the volume of waste assuming all of it has been packaged. Waste will not necessarily be packaged at the point at which it arises.

Figure 5 The routing of the UK Inventory wastes (by stored volume). Wastes from other sources that are added to the IGD by NWS are also shown

Table 3 The volume of waste broken down by waste group

Waste Group	Stored volume [m^3]	Conditioned volume [m^3]	Packaged volume [m^3]
Legacy SILW / SLLW	55,300	68,600	87,700
Legacy UILW / ULLW	154,000	273,000	350,000
RSCs	1,200	1,020	2,590
DNLEU	102,000	139,000	192,000
NB SILW	3,100	6,420	16,800
NB UILW	6,830	17,700	21,500
HLW	1,470	1,470	9,370
Legacy SF	3,830	3,830	16,600
NB SF	8,740	8,740	60,400
MOX SF	566	566	11,700
HEU	0.104	30.3	103
Pu	0.567	174	594
Total	337,000	521,000	769,000

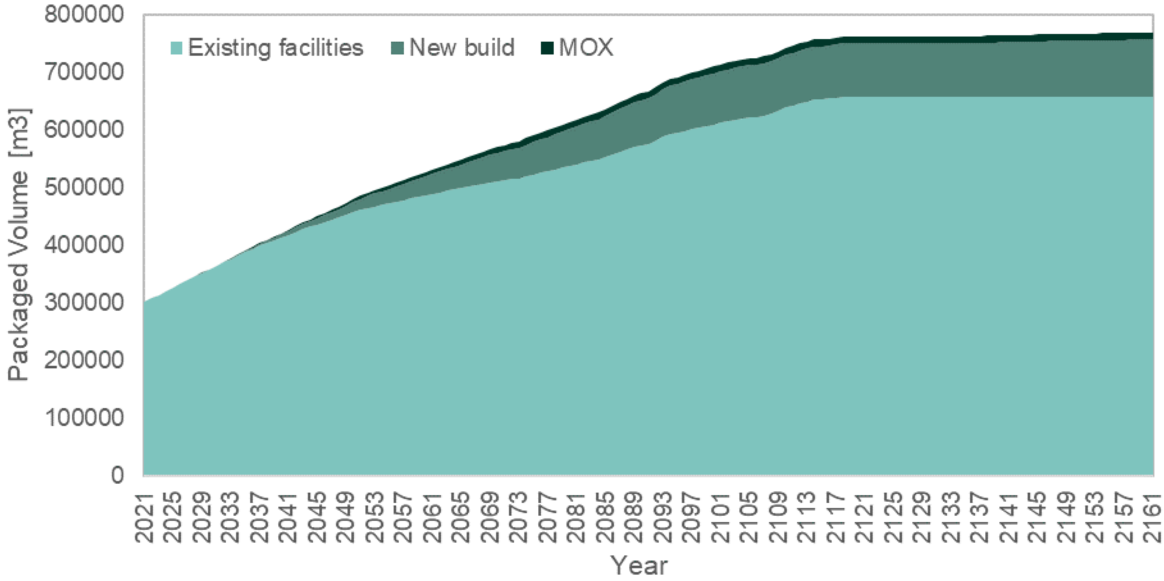

Figure 6 The arisings profile of the 2022 IGD broken down into waste from existing facilities, waste from new build facilities, and MOX SF

Disposal units

GDF throughput is measured in terms of disposal units. Most waste packages are handled singularly as disposal units; however, four 500 l drums are handled together in a stillage, which is a single disposal unit. The estimated numbers of disposal units in each waste group are presented in Table 4. The legacy UILW / ULLW waste group dominates the number of disposal units; this is consistent with the fact that this waste group is the largest contributor to total packaged volume. However, the DNLEU waste group, which contributes 25% of the packaged volume, only contributes 5% of the disposal units. This is because a significant proportion of this waste group is packaged in Transport and Disposal Containers (TDCs), which are large in comparison to other waste packages.

Radioactivity

The activity associated with the 2022 IGD at 2200 is estimated to be 46,900,000 TBq. The breakdown of the activity into the different waste groups is shown in Table 5. The activity is dominated by the spent fuels: new build spent fuel contributes 78.9%, while 7.5% is from MOX SF and 4.5% to the legacy SFs. Less than 5% of the total activity is associated with LHGW. Although these waste groups account for most of the activity at 2200, they only account for a small proportion of the overall volume of waste.

Although new build spent fuel dominates the activity for over 100,000 years after GDF closure, the activity of the DNLEU generated by extant facilities dominates the activity at later times. This is because the shorter-lived fission products will have decayed (reducing the activity of the spent fuels) whilst the longer-lived radionuclides (eg naturally occurring uranium isotope U238) from DNLEU persist. Indeed, the activity associated with DNLEU initially increases with time as the short-lived daughters of the uranium isotopes grow in. These short-lived daughters are present in natural uranium ore but are removed when the material is refined. Figure 7 shows the evolution of the activities of the different waste groups with time. The increase in the activity of the DNLEU waste group is clear.

Table 4 The number of disposal units broken down by waste group

Waste Group	Disposal units [-]	Fraction of total [%]
Legacy SILW / SLLW	4,780	2.78%
Legacy UILW / ULLW	119,000	69.1%
RSCs	1,070	<1%
DNLEU	8,840	5.13%
NB SILW	7,020	4.08%
NB UILW	8,960	5.21%
HLW	2,510	1.46%
Legacy SF	4,010	2.33%
NB SF	13,300	7.71%
MOX SF	2,570	1.49%
HEU	35	<1%
Pu	196	<1%
Total	172,000	100%

Table 5 The activity of the waste at 2200 broken down by waste group

Waste Group	Activity [TBq]	Fraction of total [%]
Legacy SILW / SLLW	$2.16\ 10^{4}$	<1%
Legacy UILW / ULLW	$3.72\ 10^{5}$	<1%
RSCs	$2.68\ 10^{3}$	<1%
DNLEU	$1.04\ 10^{4}$	<1%
NB SILW	$3.38\ 10^{2}$	<1%
NB UILW	$1.91\ 10^{6}$	4.08%
HLW	$1.90\ 10^{6}$	4.05%
Legacy SF	$2.11\ 10^{6}$	4.50%
NB SF	$3.70\ 10^{7}$	78.9%
MOX SF	$3.52\ 10^{6}$	7.52%
HEU	$2.34\ 10^{0}$	<1%
Pu	$4.37\ 10^{4}$	<1%
Total	$4.69\ 10^{7}$	100%

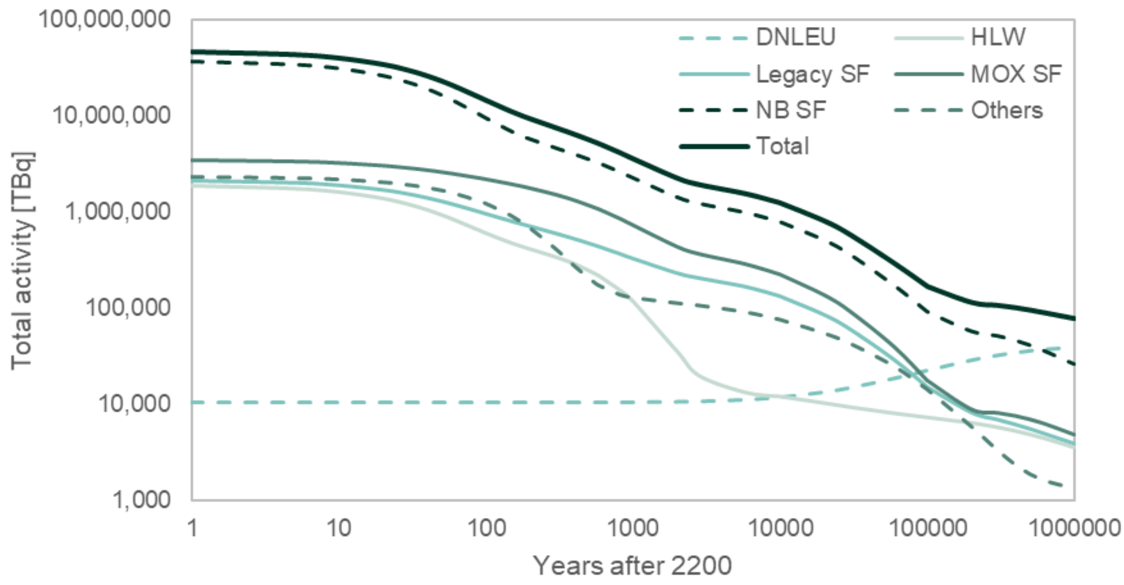

Figure 7 The evolution of the total activity of key waste groups. Minor contributors have been grouped together into 'Others'.

Materials

The IGD considers the following types of materials that will be present in the GDF:

- materials associated with waste are discussed in the *Waste Materials* sub-section
- materials associated with the GDF construction and operation are discussed in the *GDF Construction Materials* sub-section
- materials associated with the conditioning[12], capping and packaging of the waste are reported in *Appendix C: Waste materials*

Waste Materials

Table 6 shows the waste materials that make up the IGD split into three broad categories: metals, organics, and inorganics. The data presented only take account of the stored form of the waste. Where the waste has been conditioned, this will include the conditioning matrix.

The IGD is dominated by inorganics, which account for approximately 78% of the waste materials by mass; metals account for approximately 19%; organics account for approximately 2%. The remainder (approximately 0.4% by mass) is not specified. *Appendix A: Waste Group Datasheets* provides information on the key waste materials in each waste group.

It is assumed that superplasticisers are present in cements used in the construction of legacy facilities, some of which will be disposed of to a GDF. The chemical composition of superplasticisers means that they could complex with actinides and potentially increase their solubility. The 2022 IGD adopts a conservative assumption that all cementitious materials (including wastes, encapsulating and capping materials, and waste containers) contain 0.5 wt% superplasticiser.

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[12] Note that where a package has already been conditioned, the conditioning matrix is accounted for as part of the waste materials rather than separately.

Table 6 The waste material masses and the percentage of the total mass

	Waste Material	Mass [t]	Percentage of total [%]
Metals	Aluminium (and alloys)	852	<1%
	Copper (and alloys)	310	<1%
	Iron	3,200	<1%
	Lead	490	<1%
	Magnox / magnesium	5,890	1.05%
	Nickel (and alloys)	377	<1%
	Other ferrous metals	44,900	7.98%
	Stainless steel	42,300	7.53%
	Uranium	2,040	<1%
	Zircaloy / zirconium	8,490	1.51%
	Other metals	352	<1%
	Total metals	109,000	19.4%
Organics	Cellulose	1,060	<1%
	Halogenated plastics	3,300	<1%
	Hydrocarbons	60.5	<1%
	Non-halogenated plastics	2,260	<1%
	Organic ion ex. Resins	3,190	<1%
	Rubbers	1,250	<1%
	Other organics	100	<1%
	Total organics	11,200	2.00%
Other materials	Asbestos	64.8	<1%
	Cementitious material	58,600	10.42%
	Glass, ceramics, sand	3,920	<1%
	Graphite	65,900	11.72%
	Heavy metal oxide	277,000	49.32%
	Ion ex. Resins	3,150	<1%
	Sludges & flocs	22,100	3.94%
	Soil, brick, stone & rubble	1,050	<1%
	Other inorganics	7,470	1.33%
	Total other materials	439,000	78.1%
	Total unspecified	2,210	<1%

GDF Construction Materials

Some equipment and materials used for construction and operation of the GDF will remain in-situ underground after closure. For example, crane rails used in the emplacement of waste packages in vaults, engineering barriers such as the backfill material and any plugs and seals. In addition, some materials that are required to ensure the integrity of the GDF during operations (e.g. concrete, rock bolts, some electronics and monitoring systems) will remain after GDF closure. This material will contribute to the total inventory of non-radiological substances and processes such as gas generation; it is therefore important that it is recorded so that it can be included in NWS's safety case work. The exact nature and quantity of this equipment will not be fully determined until the GDF site has been selected and the GDF design finalised; however, estimates have been made based on:

- the illustrative generic GDF designs in each of the three host rocks considered in NWS's generic DSSC: higher strength rock, lower strength sedimentary rock and evaporite rock
- existing equipment commonly used to construct and operate underground facilities
- other equipment associated with nuclear facilities.

The equipment was further broken down into constituent key material types. The GDF designs, the equipment used, and the material composition of this equipment, are all subject to change.

The construction and operation materials that will remain underground after closure are estimated:

- per vault for LHGW and per disposal tunnel for HHGW; this allows the estimates to be scaled to the appropriate number of vaults / tunnels
- for the whole GDF for the 'shafts and drift' and 'common service areas'.

Appendix C: Waste materials presents estimates for each of the key material types for each of the three host rocks.

Uncertainty

The IGD characterises uncertainty of two aspects: uncertainties in the data, which is captured through uncertainty factors reported in the UK Inventory; and uncertainties in assumptions, which are explored through the use of alternative scenarios.

Assumptions have been made to compile the data for the IGD; these are necessitated by several factors including the uncertainty associated with waste packaging and characterisation of waste. The uncertainty associated with how waste will be packaged reduces as waste streams progress through NWS's Disposability Assessment process. Characterisation of the waste, whether to support disposability assessment work or as part of the packaging of the waste reduces the uncertainty surrounding the material composition and radionuclide inventory of the waste.

New build uncertainty

Although data have been included for a 24 GW(e) new build programme, the composition and timing of this are uncertain. Published reactor designs, operating strategies and decommissioning plans for new nuclear technologies do not currently contain sufficient detail on the wastes that would be produced. An uncertainty is therefore present in the volume and type of wastes that may arise from a fleet of SMRs / AMRs.

For the 2022 IGD, the new build inventories for SMR / AMR have been assumed to be the same, per GW(e), as the inventories associated with the UK EPR[13], which is a conventional large-scale reactor. However, it is anticipated that new reactor designs and their operating conditions will deviate from those of the UK EPR; this is especially true for AMRs.

The inventories for SMR / AMR will ultimately depend on the types of technology that are employed. CoRWM report the following factors as influencing the amount and type of radioactive waste generated from a nuclear reactor [13]:

- Fuel type
- Fuel enrichment
- Burnup
- Refuel cycle
- Reactor size
- Coolant / moderator choice
- Open or closed fuel cycle

Further discussion of the wastes from SMRs and AMRs can be found in references [14, 15].

NWS will continue to monitor the available information regarding SMRs and AMRs and will periodically update the assumptions and data associate with these new build reactors.

[13] Available in UK Inventory submissions for Hinkley Point C and the GDA documents [18] [18]

Volume uncertainty

Figure 8 shows the total packaged volume from the 2022 IGD reference scenario and alternative scenarios. At this stage in the programme there remain uncertainties regarding the quantity of waste; however, this will reduce as wastes are characterised and facilities decommissioned.

The *Summary of the Reference Scenario* presents information that is based on the best available data and assumptions regarding, for example, the timing and size of a new build programme. *Summary of the Alternative Scenarios* presents details of alternative scenarios that NWS have considered to explore the uncertainty in the assumptions that have been made. Figure 8 also includes the packaged volume of these scenarios.

Scenario B shows an increase in the volume of waste and this is associated with the assumption that additional depleted uranium tails need to be managed in a GDF.

Scenario C is seen to have a considerably lower packaged volume than the reference scenario. This is a result of a combination of factors; namely the exclusion of depleted uranium tails (which are assumed to be held in abeyance), the assumption that wastes potentially suitable for near-surface disposal are routed to a near-surface disposal facility, and the assumption that wastes potentially suitable for thermal treatment are thermally treated. Table 7 shows the stored, conditioned and packaged volume associated with each of the scenarios.

Table 7 The volume associated with the 2022 IGD Reference scenario and alternative scenarios

	2022 IGD	Scenario B	Scenario C
Stored volume [m^3]	337,000	430,000	210,000
Conditioned volume [m^3]	521,000	641,000	281,000
Packaged volume [m^3]	769,000	938,000	427,000

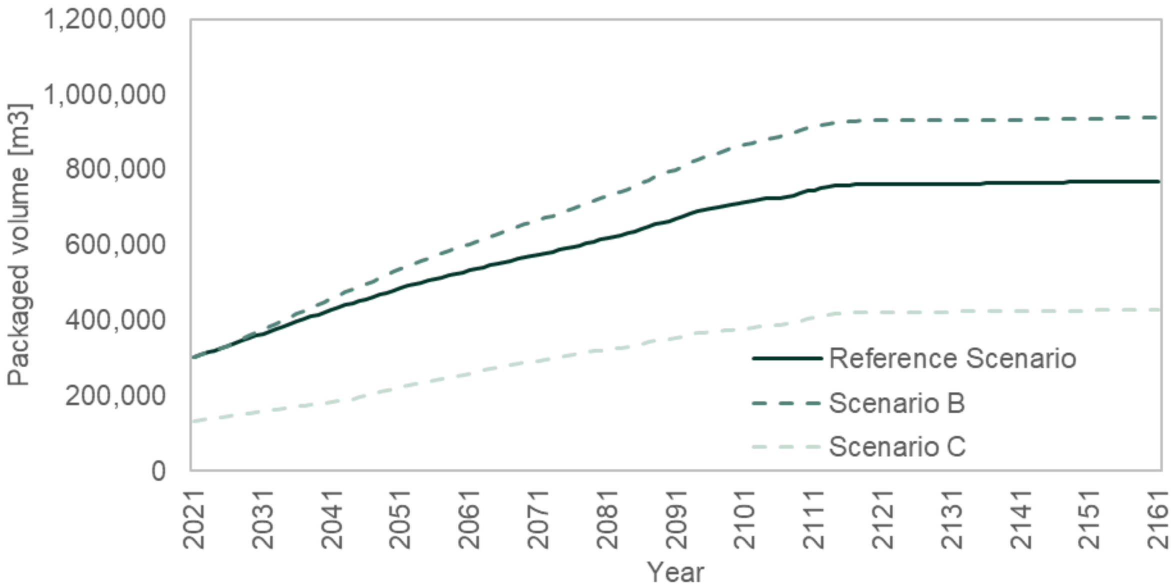

Figure 8 Uncertainty in the forecasted packaged waste volume over time

Activity uncertainty

The uncertainty in the activity is illustrated through use of the alternative scenarios (see Table 8). Scenario B, which includes additional DNLEU does not increase the activity significantly, while Scenario C, which assumes a smaller new build programme has a significant lower activity.

The activity of the alternative scenarios do not show a significant increase in the total activity; however, it is noted that the uncertainty factors assigned in the UK Inventory range from a factor of 1.5 to a factor of 100. The uncertainties on the activity of the spent fuel waste streams are expected to be much lower, but have not been quantified.

Table 8 The activity associated with the 2022 IGD scenarios at 2200

Scenario	Activity [TBq]
Reference	46,900,000
Scenario B	46,900,000
Scenario C	33,400,000

Summary of changes

The IGD has been updated following the publication of the 2022 UK Inventory. The most significant change between the 2019 and 2022 IGDs is the increase in the assumed nuclear new build programme (from 16 GW(e) to 24 GW(e)).

The key change to the underpinning assumptions between the 2019 and 2022 IGD is an increase in the size and composition of the assumed nuclear new build programme; other changes are small in comparison and include:

- a large reduction in the quantity of HEU as MOD HEU is no longer assumed to come to a GDF
- a reduction in the quantity of legacy SF due to changes to AGR operational lifetimes

A summary of the changes between the 2019 and 2022 IGDs is reported here with further detail in the 'Key Changes Report' [8].

Volumes

Table 9 shows the changes to the packaged volume for each waste group. The overall impact is a negligible change in the total packaged volume (<0.5%), although there are noteworthy changes to some waste groups[14]:

- new build spent fuel has increased roughly in line with the increase in the size of the new build programme
- the ILW from a new build programme has reduced slightly, despite the increased generation capacity; this is attributable to two factors: firstly the 2022 IGD is based on data solely from the UK EPR, which is assumed to generate less ILW per GW(e) of generation capacity than the AP1000 that was previously included; secondly there has been a change to the packaging assumptions from the 2019 IGD and some waste previously assumed to be disposed of in shielded packages is now assumed to be disposed of in unshielded packages
- There has been a significant reduction in the quantity of HEU because of the revised assumptions regarding MOD HEU

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[14] In addition to the changes to the quantities of waste, the 2022 IGD assumes that HHGW is packaged in steel (rather than copper) disposal containers. This results in changes to the packaged volume that are of the order of a few percent.

Table 9 Changes to the packaged volume of each waste group between the 2019 and 2022 IGDs

Waste Group	2019 IGD [m^3]	2022 IGD [m^3]	Difference [%]
Legacy SILW / SLLW	92,600	87,700	-5.30
Legacy UILW / ULLW	372,000	350,000	-5.79
RSCs	2,610	2,590	-0.573
DNLEU	184,000	192,000	+4.33
NB SILW	18,900	16,800	-11.1
NB UILW	22,100	21,500	-2.55
HLW	9,880	9,370	-5.18
Legacy SF	17,000	16,600	-2.79
NB SF	39,400	60,400	+53.1
MOX SF	11,900	11,700	-1.97
HEU	2,470	103	-95.8
Pu	620	594	-4.16
Total	773,000	769,000	-0.498

Activities

The changes to the activities of the different waste groups are presented in Table 10 and are consistent with expectations:

- the activity associated with new build wastes has increased. In the case of the spent fuel this is greater than the 50% increase that might be expected (i.e. proportional to the increase in generation capacity between the two inventories) because the 2022 IGD has the reactors starting operations later and there has been less decay of the wastes and fuel at the reference date.
- the change to the HEU activity is consistent with the reduced quantity of material in this waste group
- the change to the legacy SF activity is partly associated with the reduction in quantity of this material and partly associated with the changes to the assumptions regarding legacy SFs (e.g. changes to the assumed burn-up of the Sizewell B and AGR spent fuels[15])

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[15] Details are presented in the 'Underpinning Report' [4]

Table 10 Changes to the activity of each waste group at 2200 between the 2019 and 2022 IGDs

Waste Group	2019 IGD [TBq]	2022 IGD [TBq]	Difference [%]
Legacy SILW / SLLW	19,400	21,600	11.2
Legacy UILW / ULLW	398,000	372,000	-6.56
RSCs	3,180	2,680	-15.7
DNLEU	9,800	10,400	6.53
NB SILW	154	338	120
NB UILW	793,000	1,910,000	141
HLW	1,460,000	1,900,000	30.3
Legacy SF	2,780,000	2,110,000	-24.2
NB SF	19,000,000	37,000,000	94.7
MOX SF	3,700,000	3,520,000	-4.79
HEU	54	2	-95.6
Pu	43,700	43,700	0
Total	28,200,000	46,900,000	66.2

Summary and key messages

The UK has been producing radioactive waste inventories for over 30 years; this is a well-established and iterative process. The IGD is based on Government policy, industry plans and publicly available information, such as the UK Inventory.

The key assumptions made in the production of the IGD are:

- quantities of legacy wastes and their time of arising are taken from the UK Inventory
- 24 GW(e) of new nuclear by 2050[16]
- 95% of the civil Pu (and all MOD Pu) is assumed to be converted to MOX fuel and irradiated in line with Government policy on the long-term management of plutonium[17] [10]
- radioactive wastes covered by the Scottish Government's policy for the management of higher activity radioactive waste [11] is excluded from the IGD
- The quantities of MOD materials are based on the Nuclear Liabilities Management Strategy [12]

Data for the reference scenario have been presented alongside summary results for the alternative scenarios. It can be seen that:

- The volume is dominated by the LHGW waste groups, but these make a small contribution to the total activity at 2200 (the assumed date of GDF closure)
- At 2200 the activity is dominated by the spent fuel waste groups, but these make a small contribution to the total volume
- Although waste and spent fuel from the assumed new build programme dominate the total activity for over 100,000 years after GDF closure, it is the legacy wastes and materials (principally the DNLEU) that dominate at extremely long timescales.

The effects of changes in the underpinning assumptions are explored in alternative scenarios:

- Scenario B, includes the effect of including the depleted uranium tails from the enrichment of reactor fuel for the 24 GW(e) new build programme
- Scenario C, includes a smaller new build programme of 16 GW(e), excludes DNLEU and wastes potentially suitable for near-surface disposal, and models the impact of thermally treating wastes that are potentially suitable for this management route.

Comparison with the reference inventory shows that Scenario B has a larger volume than the reference case (although this is within the uncertainty bounds of the reference inventory) but has a negligible impact on the total activity of the IGD. In contrast, Scenario C results in a significant reduction in both the activity and the volume compared to the reference case.

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[16] Based on modelling assumptions and policy published under the previous government.

[17] Since the development of the IGD scenarios, the UK Government has taken the policy decision to immobilise the UK's inventory of civil separated plutonium at Sellafield [18].

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[6] UK NIREX Ltd, "The identification of radionuclides relevant to long-term waste management," N/105, 2004.

[7] Nuclear Waste Services, "2022 Inventory for Geological Disposal: Implications Report," DSSC/406/03, 2025.

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[10] DECC, "Management of the UK's Plutonium Stocks: A consultation response on the long-term management of UK-owned separated civil plutonium," URN 11D/819, 2011.

[11] Scottish Government, "Scotland's Higher Activity Radioactive Waste Policy 2011," ISBN: 978-0-7559-9892-0, 2011.

[12] Defence Nuclear Organisation, "Nuclear Liabilities Management Strategy," 2022.

[13] CoRWM, "Development of small modular reactors and advanced modular reactors – implications for the management of higher activity wastes and spent fuel," CoRWM document No. 3887, 2024.

[14] L. Krall, A. Macfarlane and R. Ewing, "Nuclear waste from small modular reactors," PNAS 2022 Vol. 119 No. 23 e2111833119, 2022.

[15] T. Kim, L. Boing, W. Halsey and B. Dixon, "Nuclear Waste Attributes of SMRs Scheduled for Near-Term Deployment," ANL/NSE-22/98, Revision 1, 2022.

[16] DESNZ, *Plutonium Disposition Strategy,* UK Parliament Statement HCWS388, 2025.

[17] Nuclear Waste Services, “Generic Design Assessment: Disposability Assessment for Wastes and Spent Fuel arising from Operation of the UK EPR Part 1: Main Report,” NXA/10747397, Issue 3, 2014.

[18] Nuclear Waste Services, “Generic Design Assessment: Disposability Assessment for Wastes and Spent Fuel arising from Operation of the UK EPR Part 2: Data Sheets and Inventory Tables,” NXA/10777960, Issue 2, 2010.

Glossary

Term	Definition
AGR	Advanced gas-cooled reactor
AMR	Advanced modular reactor
Disposal unit	A waste package, or group of waste packages that is handled as a single unit for the purposes of transport and disposal.
DNLEU	Depleted, natural and low enriched uranium
DSSC	Disposal System Safety Case
DU	Depleted uranium
EVR	Evaporite Rock
GDF	Geological disposal facility
GW(e)	Giga-Watts of electrical power (as opposed to GW(th), giga-Watts of thermal power)
HAW	Higher activity radioactive waste
HEU	Highly enriched uranium
HHGW	High heat generating waste
HLW	High level waste
HSR	Higher Strength Rock
IGD	Inventory for geological disposal
ILW	Intermediate level waste
JET	Joint European Torus
LHGW	Low heat generating waste
LLW	Low level waste
LLWR	Low Level Waste Repository
LSSR	Lower Strength Sedimentary Rock
LWR	Light water reactor
MDU	Magnox depleted uranium
MOD	Ministry of Defence
MOX	Mixed oxide fuel

Term	Definition
NDA	Nuclear Decommissioning Authority
NWS	Nuclear Waste Services
PFR	Prototype fast reactor
Pu	Plutonium
PWR	Pressurised water reactor
RSC	Robust shielded container
SF	Spent fuel
SGHWR	Steam-generating heavy water reactor
SILW	Shielded intermediate level waste
SLLW	Shielded low level waste
SMR	Small modular reactor
TDC	Transport and 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 EPR	The reactor design that is being built at Hinkley Point C
UK Inventory	The UK Radioactive Waste and Materials Inventory, can also be referred to as the UK RWI or UK RWMI
ULLW	Unshielded low level waste
WAGR	Windscale advanced gas-cooled reactor

Appendix A: Waste Group Datasheets

Highly Enriched Uranium (HEU)

Details

Highly enriched uranium comprises residues from reprocessing facilities and fuel fabrication.

The total activity at 2200 is estimated to be 2.34 TBq, with the majority being uranium isotopes (principally U234) and their daughters.

The material composition is entirely heavy metal oxide.

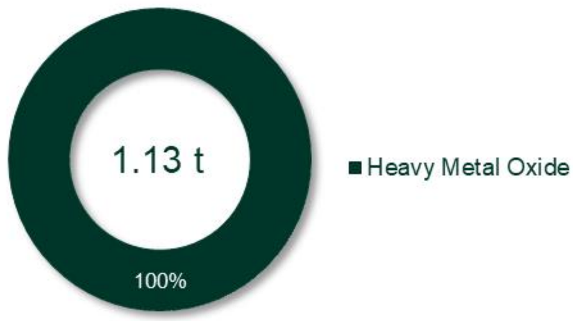
Packaged volume and disposal units

Package	Packaged Volume [m^3]	Disposal Units [-]
HEU/Pu disposal container	103	35

Activity of priority radionuclides at 2200

Nuclide	Activity [TBq]	Nuclide	Activity [TBq]
C14	0	Cs135	0
Cl36	0	Cs137	0
Co60	0	U233	0
Se79	0	U235	$7.60\ 10^{-2}$
Kr85	0	U238	$5.02\ 10^{-4}$
Tc99	0	Np237	0
I129	0		

Materials



Arisings profile

No arising profile presented as all HEU is in stock on 01/04/22.

Plutonium (Pu)

Details

The 22 IGD reports 5.75 t of plutonium that is not suitable for manufacture of MOX fuel. The total packaged volume of Pu waste is 594 m^3 associated with 196 disposal units. The total activity of the Pu at 2200 is estimated to be 43,700 TBq at 2200 and is dominated by plutonium isotopes and their daughters.

The material composition is entirely heavy metal oxide.

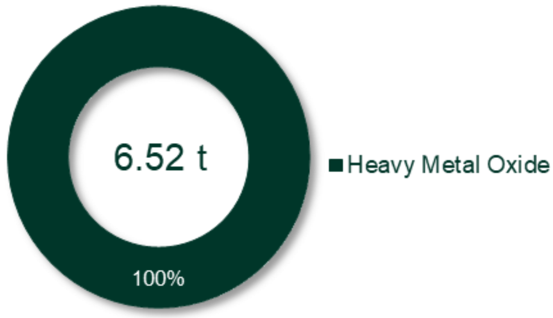
Packaged volume and disposal units

Package	Packaged Volume [m^3]	Disposal Units [-]
HEU/Pu disposal container	594	196

Activity of priority radionuclides at 2200

Nuclide	Activity [TBq]	Nuclide	Activity [TBq]
C14	6.12 10^{-8}	Cs135	3.05 10^{-8}
Cl36	2.39 10^{-10}	Cs137	1.26 10^{-5}
Co60	2.54 10^{-19}	U233	6.26 10^{-4}
Se79	1.31 10^{-8}	U235	2.48 10^{-3}
Kr85	5.22 10^{-11}	U238	3.54 10^{-6}
Tc99	4.51 10^{-7}	Np237	1.23
I129	9.51 10^{-10}		

Materials



Arisings profile

No arising profile presented as all plutonium is in stock on 01/04/22.

Legacy SILW / SLLW

Details

This waste group deals with the legacy wastes that are packaged in shielded waste containers.

The total activity of this waste group at 2200 is 21,600 TBq, with C14 (29.8%) from Magnox / AGR core graphite and Ni63 (67.8%) from steels the main contributors; the priority 1 radionuclides are presented below.

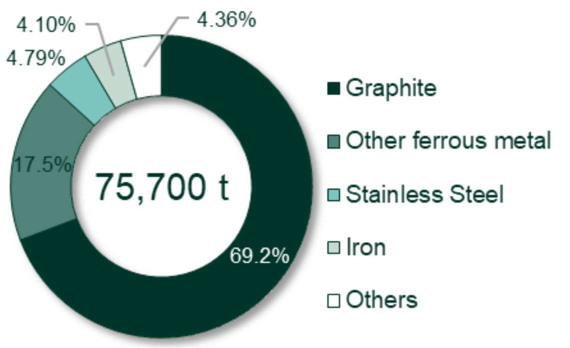
Packaged volume and disposal units

Package	Packaged Volume [m^3]	Disposal Units [-]
2 m box	245	24
4 m box	76,100	3,800
6 m^3 concrete box	11,400	960

Activity of priority radionuclides at 2200

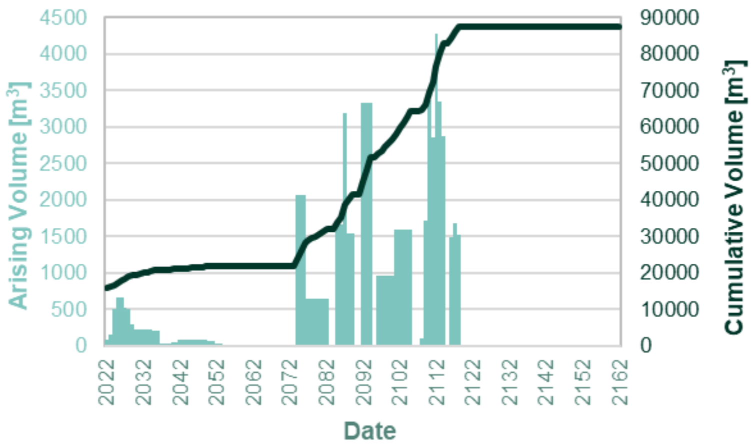
Nuclide	Activity [TBq]	Nuclide	Activity [TBq]
C14	$6.44\ 10^{3}$	Cs135	$4.23\ 10^{-2}$
Cl36	26.0	Cs137	11.4
Co60	$7.65\ 10^{-4}$	U233	$5.22\ 10^{-2}$
Se79	$3.12\ 10^{-4}$	U235	$3.08\ 10^{-4}$
Kr85	$5.23\ 10^{-5}$	U238	$6.43\ 10^{-3}$
Tc99	0.383	Np237	$2.80\ 10^{-2}$
I129	$2.12\ 10^{-4}$		

Materials



The total mass of waste is 75,700 t, with the most significant material being graphite (predominantly from the cores of AGRs and Magnox reactors). "Others" is largely cementitious materials (2.20%).

Arisings profile



The figure shows the arising and cumulative packaged volume of waste with time. The large spikes in volumes are associated with arisings from final site clearance at Magnox and AGR sites, with the majority being from reactor graphite.

Legacy UILW / ULLW

Details

This waste group deals with the legacy wastes that are packaged in unshielded waste containers. The total packaged volume is 350,000 m^3 associated with 119,000 disposal units.

The total activity of this waste group at 2200 is 372,000 TBq, with Ni63 (71.7%) and Am241 (7.21%) the main contributors. The priority 1 radionuclides are presented below.

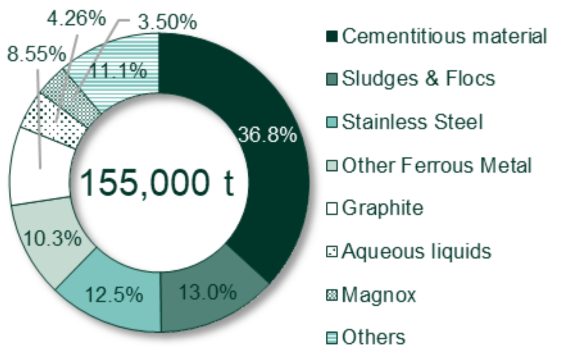
Packaged volume and disposal units

Package	Packaged Volume [m^3]	Disposal Units [-]
500 litre drum	102,000	44,500
3 m^3 box (side lifting)	61,000	18,700
3 m^3 box (corner lifting)	179,000	53,800
3 m^3 drum	198	76
MBGWS box	8,710	1850

Activity of priority radionuclides at 2200

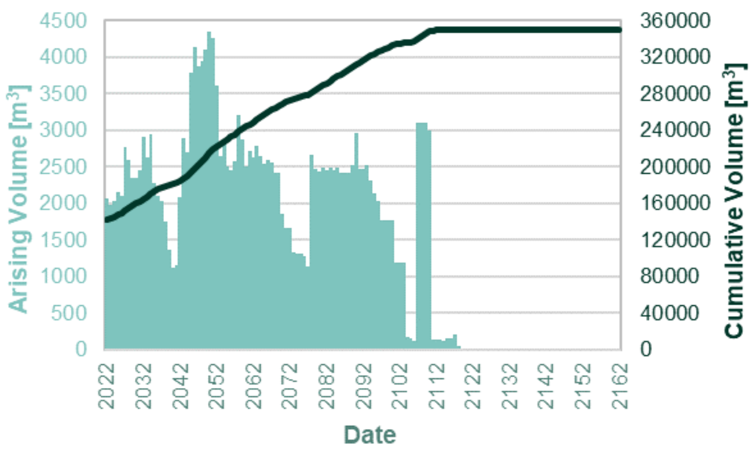
Nuclide	Activity [TBq]	Nuclide	Activity [TBq]
C14	$1.38\ 10^{3}$	Cs135	6.50
Cl36	3.88	Cs137	$6.71\ 10^{3}$
Co60	$7.30\ 10^{-5}$	U233	0.906
Se79	0.407	U235	0.618
Kr85	$3.12\ 10^{-2}$	U238	21.1
Tc99	$1.28\ 10^{3}$	Np237	94.0
I129	2.27		

Materials



The waste group contains a range of materials and the main contributors to "Others" are Halogenated Plastics (2.01%) and inorganic ion exchange resins (1.90%).

Arisings profile



The figure shows the arising and cumulative packaged volume of waste with time. Unshielded legacy waste arises continuously because the waste arising from decommissioning activities at Sellafield is expected to continue throughout the period that the reactors are in their care and maintenance phase. Spikes in the arisings are associated with specific events; for example, the peak from 2107 to 2111 is predominantly associated with final site clearance wastes at Calder Hall.

Robust Shielded Containers

Details

This waste group deals with the legacy wastes that are packaged in robust shielded waste containers. The total packaged volume is 2,590 m^3 associated with 1,070 disposal units.

The total activity of this waste group at 2200 is 2,680 TBq, with Ni63 (95.8%) the main contributor. The priority 1 radionuclides are presented below.

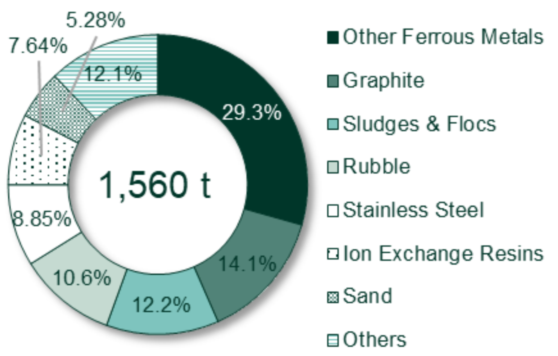
Packaged volume and disposal units

Package	Packaged Volume [m^3]	Disposal Units [-]
500 l robust shielded drum	1,030	779
3 m^3 robust shielded box	1,570	288

Activity of priority radionuclides at 2200

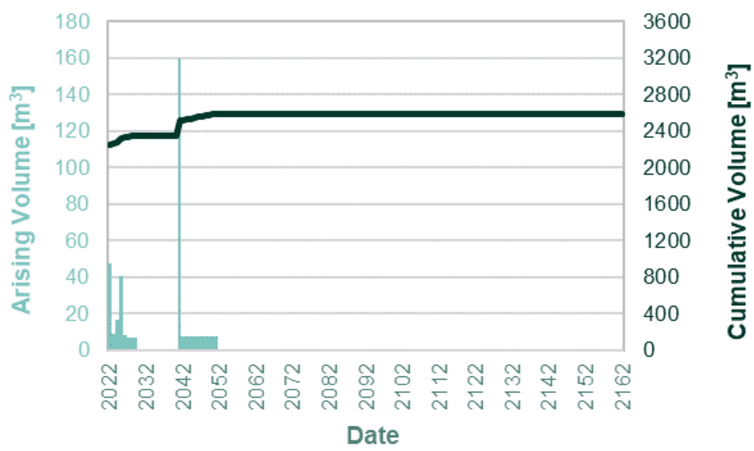
Nuclide	Activity [TBq]	Nuclide	Activity [TBq]
C14	21.0	Cs135	$3.63\ 10^{-3}$
Cl36	0.822	Cs137	6.07
Co60	$6.86\ 10^{-6}$	U233	$2.37\ 10^{-4}$
Se79	$1.49\ 10^{-4}$	U235	$1.41\ 10^{-4}$
Kr85	$3.08\ 10^{-5}$	U238	$4.79\ 10^{-3}$
Tc99	$9.49\ 10^{-2}$	Np237	$3.10\ 10^{-2}$
I129	$3.90\ 10^{-4}$		

Materials



The waste group contains a range of materials and the main contributors to “Others” are inorganic ion exchange resins (2.62%), aqueous liquids (2.61%) and Magnox (2.29%).

Arisings profile



The figure shows the arising and cumulative packaged volume of waste with time. This waste group is associated with a range of waste types across multiple sites. The earlier block of arisings is associated with waste packaging on Magnox reactor sites, while the later block of arisings is associated with waste packaging at Sizewell B.

New build shielded ILW

Details

This waste group deals with the wastes from new build reactors that are packaged in shielded waste containers. The total packaged volume is 16,800 m^3 associated with 7,020 disposal units.

The total activity of this waste group at 2200 is 338 TBq, with Ni63 (90.2%) the main contributor. The priority 1 radionuclides are presented below.

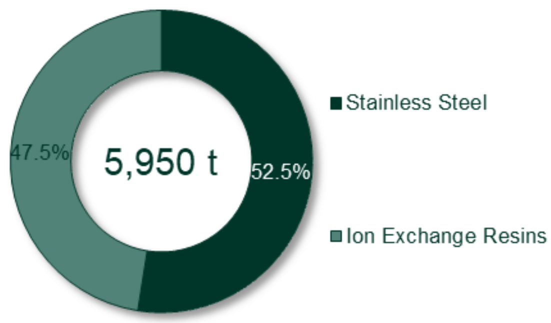
Packaged volume and disposal units

Package	Packaged Volume [m^3]	Disposal Units [-]
4 m box	3,050	153
1 m^3 concrete drum	13,700	6,860

Activity of priority radionuclides at 2200

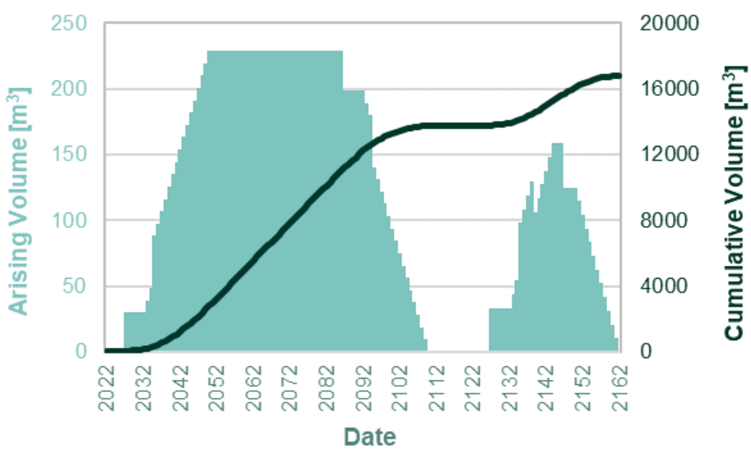
Nuclide	Activity [TBq]	Nuclide	Activity [TBq]
C14	4.93	Cs135	$8.70\ 10^{-4}$
Cl36	$2.94\ 10^{-3}$	Cs137	9.35
Co60	$1.06\ 10^{-2}$	U233	$4.59\ 10^{-5}$
Se79	$1.02\ 10^{-3}$	U235	$9.40\ 10^{-7}$
Kr85	$6.13\ 10^{-4}$	U238	$2.31\ 10^{-5}$
Tc99	$2.51\ 10^{-2}$	Np237	$6.71\ 10^{-5}$
I129	$1.74\ 10^{-4}$		

Materials



The contributors are stainless steel from the reactor pressure vessel and organic ion exchange resins.

Arisings profile



The figure shows the arising and cumulative packaged volume of waste with time. The step changes seen in the arisings profile are associated with the two large-scale reactors (Hinkley Point C and Sizewell C) starting and finishing operations. The smaller steps are associated with the SMRs / AMRs.

The earlier block of arisings is associated with the operations of the reactors, while the second block of arisings is associated with the decommissioning of the reactors.

New build unshielded ILW

Details

This waste group deals with the wastes from new build reactors that are packaged in shielded waste containers. The total packaged volume is 21,500 m^3 associated with 8,960 disposal units.

The total activity of this waste group at 2200 is 1,910,000 TBq, with Ni63 (97.7%) the main contributor. The priority 1 radionuclides are presented below.

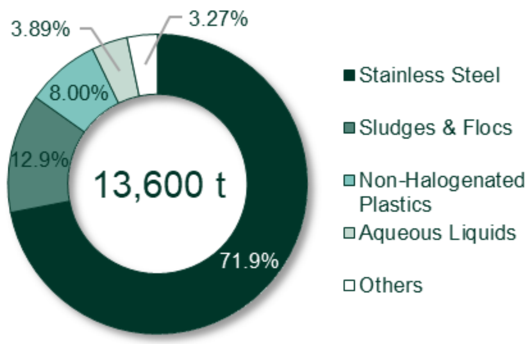
Packaged volume and disposal units

Package	Packaged Volume [m^3]	Disposal Units [-]
500 l drum	18,000	7,880
3 m^3 box (side lifting)	3,540	1,080

Activity of priority radionuclides at 2200

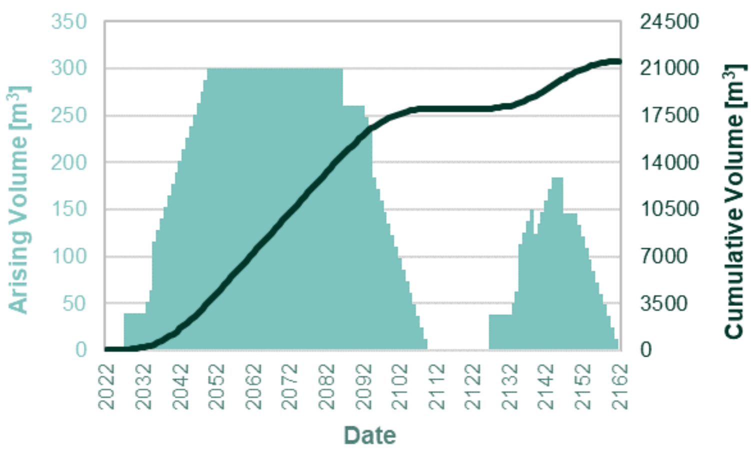
Nuclide	Activity [TBq]	Nuclide	Activity [TBq]
C14	1.40 10^4	Cs135	1.49 10^{-2}
Cl36	1.28	Cs137	108
Co60	53.3	U233	0.124
Se79	0.899	U235	1.26 10^{-5}
Kr85	1.65	U238	1.18 10^{-4}
Tc99	62.7	Np237	1.08 10^{-3}
I129	1.10 10^{-3}		

Materials



The bulk of the waste is stainless steel reactor components, largely from cartridge filters and reactor internals.

Arisings profile



The figure shows the arising and cumulative packaged volume of waste with time. The step changes seen in the arisings profile are associated with the two large-scale reactors (Hinkley Point C and Sizewell C) starting and finishing operations. The smaller steps are associated with the SMRs / AMRs.

The earlier block of arisings is associated with the operations of the reactors, while the second block of arisings is associated with the decommissioning of the reactors.

Depleted, Natural and Low Enriched Uranium (DNLEU)

Details

The main components of the DNLEU inventory are:

- 23,100 tU MDU in 200 l drums
- 14,900 tU MDU in 210 l drums
- 4,930 tU TPU
- 152,000 tU depleted uranium tails
- 5,000 tU defence DU (in DV-70s)
- 4,000 tU defence DU (in 200 l drums)
- 3,240 tU Miscellaneous DNLEU
- 230 tU UF_4

The total packaged volume is 192,000 m^3 associated with 8,840 disposal units.

The total activity of this waste group at 2200 is 10,400 TBq, with members of the U238 decay chain the main contributors: U238, Th234 and Pa234 (each 26.4%), and U234 (16.5%). The priority 1 radionuclides are presented below.

Packaged volume and disposal units

Package	Packaged Volume [m^3]	Disposal Units [-]
500 l drum	4,960	2,170
Uranium TDC (2.1 m high)	11,700	460
Uranium TDC (2.3 m high)	126,000	4,510
Uranium TDC (2.4 m high)	49,300	1,700

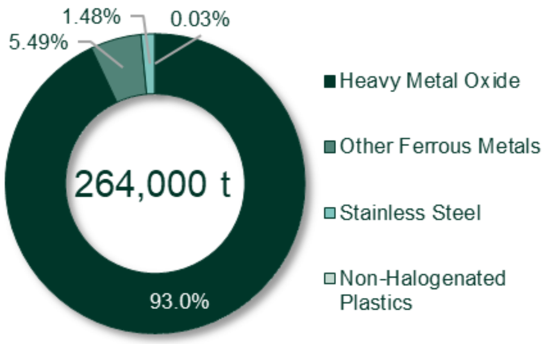
DNLEU is assumed to be disposed of as follows:

- 4 DV-70s of DU tails in a 2.3 m high TDC
- 28 200 l drums of MDU in a 2.4 m high TDC
- 54 210 l drums of MDU in a 2.1 m high TDC
- Repackaging in 500 l drums is assumed for the remaining DNLEU.

Activity of priority radionuclides at 2200

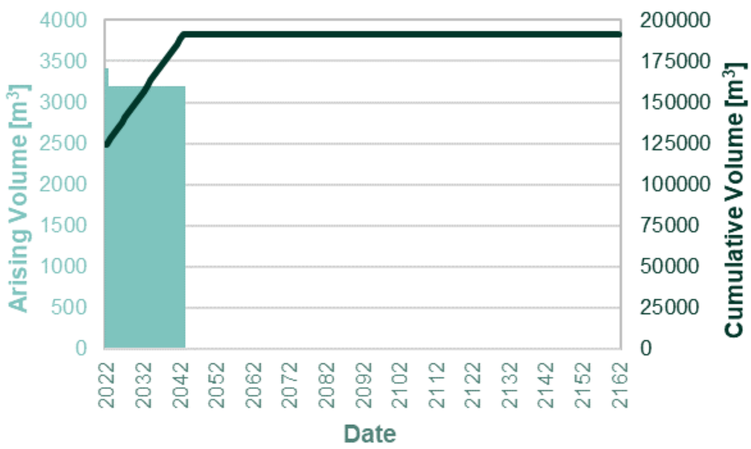
Nuclide	Activity [TBq]	Nuclide	Activity [TBq]
C14	$7.18\ 10^{-10}$	Cs135	$2.59\ 10^{-8}$
Cl36	0	Cs137	$5.39\ 10^{-5}$
Co60	0	U233	$2.32\ 10^{-3}$
Se79	$1.91\ 10^{-9}$	U235	64.6
Kr85	0	U238	$2.76\ 10^{+3}$
Tc99	31.0	Np237	2.50
I129	$1.73\ 10^{-9}$		

Materials



Most of the waste is uranium oxides, with some stainless steel and non-halogenated plastics associated with the way that materials have been stored.

Arisings profile



The figure shows the arising and cumulative packaged volume of waste with time. Arisings of DNLEU from enrichment activities at Capenhurst are estimated to 2039; following the packaging of this waste, no further arisings have been included.

Legacy spent fuel

Details	Packaged volume and disposal units

Details

The types of legacy spent fuels considered are:

- 4,530 tU AGR spent fuel
- 1,020 tU Sizewell B spent fuel
- 1,040 tU Metallic spent fuel (assumed to be low burn-up Magnox spent fuel)
- 68.1 tU SGHWR spent fuel
- 21.0 tU WAGR spent fuel
- 69.0 tU Miscellaneous LWR spent fuel
- 8.21 tHM PFR Spent fuel

The total packaged volume is 16,600 m^3 associated with 4,010 disposal units.

The total activity of this waste group at 2200 is 2,110,000 TBq, with Am241 (24%), Cs137 (14.8%) and its daughter Ba137m (14.0%) the main contributors. The priority 1 radionuclides are presented below.

Packaged volume and disposal units

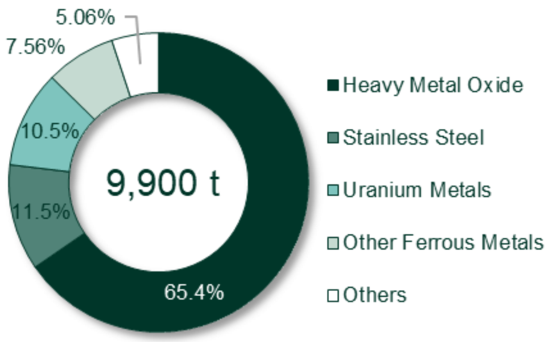
Package	Packaged Volume [m^3]	Disposal Units [-]
AGR disposal container	9,610	2,240
Magnox disposal container	4,610	1,170
PFR disposal container	46.8	17
PWR disposal container	2,290	586

WAGR SF and SGHWR SF are assumed to be disposed of in an AGR disposal container; miscellaneous LWR SF is assumed to be disposed of in a PWR disposal container

Activity of priority radionuclides at 2200

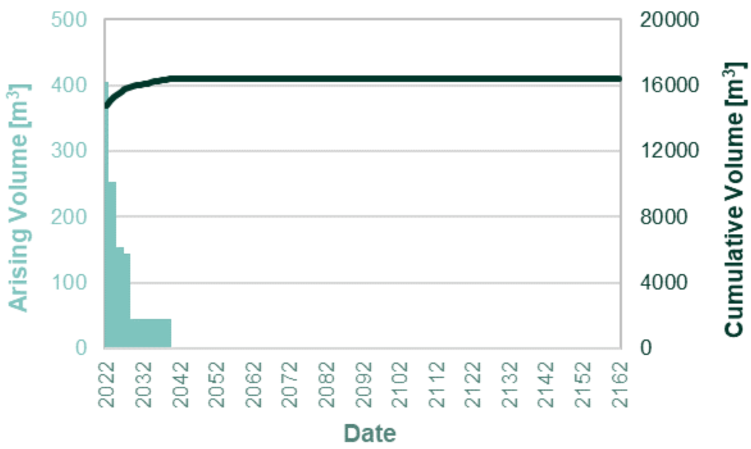
Nuclide	Activity [TBq]	Nuclide	Activity [TBq]
C14	$1.11\ 10^{3}$	Cs135	110
Cl36	2.80	Cs137	$3.12\ 10^{5}$
Co60	$2.60\ 10^{-5}$	U233	0.269
Se79	20.4	U235	3.78
Kr85	13.2	U238	79.7
Tc99	$1.79\ 10^{3}$	Np237	76.0
I129	6.95		

Materials



The main contributors are the fuel (heavy metal oxide and uranium) and cladding materials (others includes Zircaloy (3.09%) and Magnox(1.19%) cladding).

Arisings profile



The figure shows the arising and cumulative packaged volume of waste with time. Most of the legacy fuels have already been generated; the arisings are from the continued operation of the AGRs and Sizewell B, with the step changes in the arisings profile representing the dates at which these reactors are assumed to shut down.

New build spent fuel

Details

The fuels associated with the assumed new build programme are based on those for the UK EPR.

The total activity of this waste group at 2200 is 37,000,000 TBq, with Cs137 (23.5%) and its daughter Ba137m (22.2%), Sr90 (14.0%) and its daughter Y90 (14.0%), and Am241 (12.7%) the main contributors. The priority 1 radionuclides are presented below.

Packaged volume and disposal units

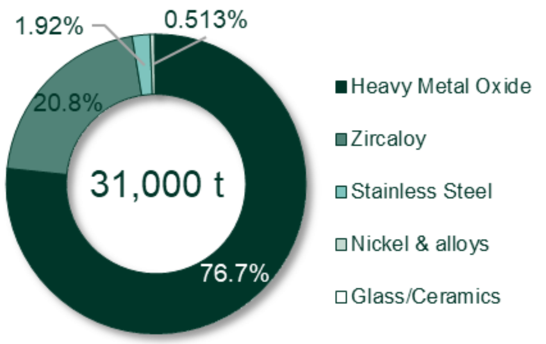
Package	Packaged Volume [m^3]	Disposal Units [-]
New build disposal container	60,400	13,300

The New build SF is assumed to have a burn-up of 65 GWd/tU, appropriate for a disposal container accommodating 3 SF assemblies.

Activity of priority radionuclides at 2200

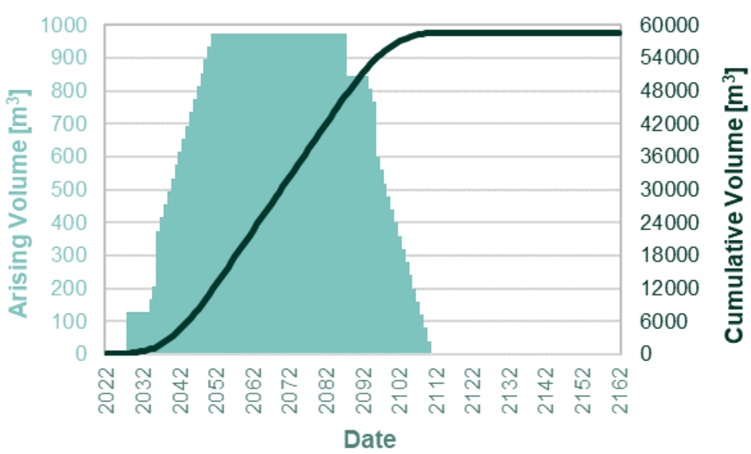
Nuclide	Activity [TBq]	Nuclide	Activity [TBq]
C14	3.08 10^3	Cs135	3.08 10^3
Cl36	156	Cs137	156
Co60	0.159	U233	0.159
Se79	87.0	U235	87.0
Kr85	5.00 10^3	U238	5.00 10^3
Tc99	1.88 10^4	Np237	1.88 10^4
I129	47.9		

Materials



The main materials associated with this waste group are the heavy metal oxide fuel and the zircaloy cladding.

Arisings profile



The figure shows the arising and cumulative packaged volume of waste with time. The step changes seen in the arisings profile are associated with the two large-scale reactors (Hinkley Point C and Sizewell C) starting and finishing operations. The smaller steps are associated with the SMRs / AMRs.

MOX spent fuel

Details

It is assumed that 95% of the civil Pu (and all the MOD Pu) is re-used as light water reactor MOX fuel containing 8% Pu and that this is irradiated to 50 GWd/tHM.

The total activity of this waste group at 2200 is 3,520,000 TBq, with Am241 (48.0%) and Pu238 (14.4%), the main contributors. The priority 1 radionuclides are presented below.

Packaged volume and disposal units

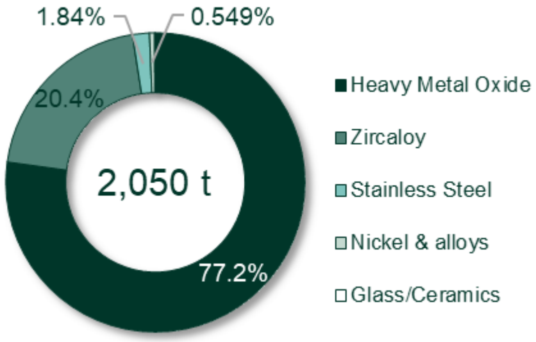
Package	Packaged Volume [m^3]	Disposal Units [-]
MOX disposal container	11,700	2,570

A MOX disposal container can accommodate one MOX SF assembly.

Activity of priority radionuclides at 2200

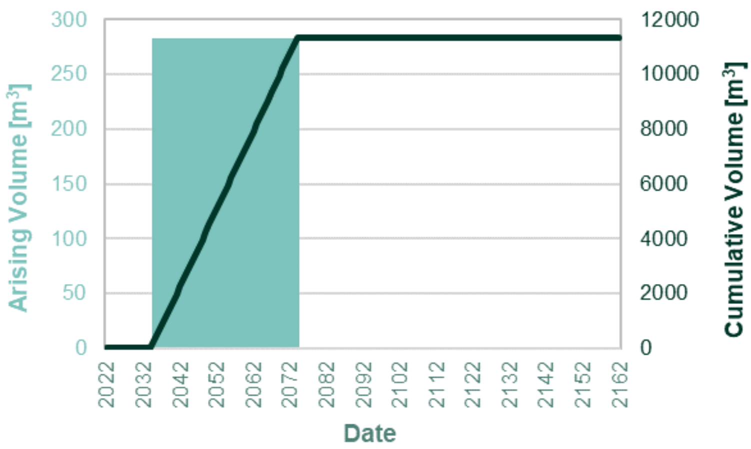
Nuclide	Activity [TBq]	Nuclide	Activity [TBq]
C14	223	Cs135	79.8
Cl36	1.46	Cs137	$2.97\ 10^{5}$
Co60	$1.80\ 10^{-2}$	U233	0.303
Se79	4.07	U235	0.140
Kr85	39.4	U238	15.2
Tc99	990	Np237	84.1
I129	3.12		

Materials



The main materials associated with this waste group are the heavy metal oxide fuel and the zircaloy cladding.

Arisings profile



The figure shows the arising and cumulative packaged volume of waste with time. The MOX fuel is assumed to be irradiated for a 40 year period starting in 2035 and the arisings have been equally split over this period.

High level waste (HLW)

Details

HLW was generated from the reprocessing of Magnox and oxide spent fuels and further will be generated during post-operational clean-out of the vitrification plant facilities.

The total activity of this waste group at 2200 is 1,900,000 TBq, with Am241 (27.0%), Cs137 (22.2%) and its daughter Ba137m (21.0%), and Sr90 and its daughter Y90 (13.2% each) the main contributors. The priority 1 radionuclides are presented below.

Packaged volume and disposal units

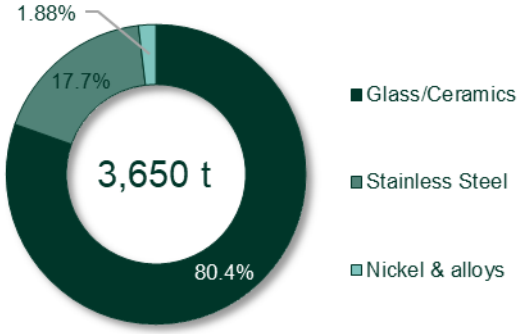
Package	Packaged Volume [m^3]	Disposal Units [-]
HLW disposal container	9,370	2,510

The HLW disposal container is assumed to accommodate 3 waste vitrification plant containers.

Activity of priority radionuclides at 2200

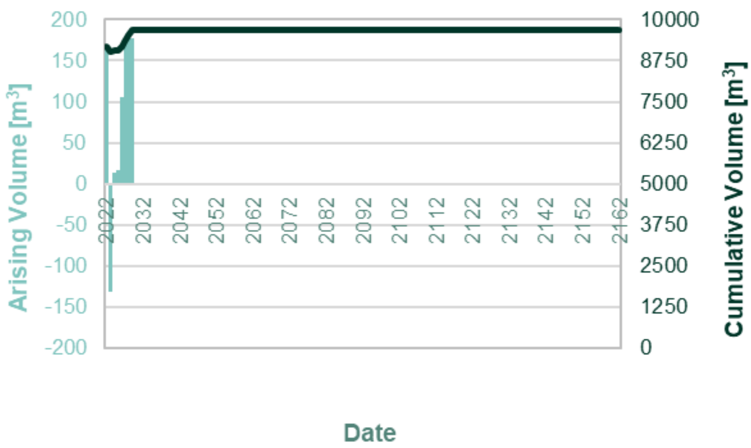
Nuclide	Activity [TBq]	Nuclide	Activity [TBq]
C14	0	Cs135	350
Cl36	0	Cs137	$4.22\ 10^{5}$
Co60	$2.05\ 10^{-7}$	U233	$7.32\ 10^{-2}$
Se79	31.9	U235	$1.50\ 10^{-2}$
Kr85	0	U238	0.279
Tc99	$4.97\ 10^{3}$	Np237	104
I129	0		

Materials



The most significant material components of this waste group are the vitrified glass product and stainless steel from the waste vitrification plant canisters.

Arisings profile



The figure shows the arising and cumulative packaged volume of waste with time. A proportion of the HLW results from the reprocessing of overseas spent fuels. All reprocessing contracts with overseas customers that have been signed since 1976 include a provision to return packaged wastes to the country of origin. Waste substitution arrangements are being implemented whereby an additional amount of HLW from reprocessing is returned, which is smaller in volume but equivalent in radiological terms to the customers' ILW and LLW that would otherwise be returned.

The negative arisings shown in the figure represent the return of HLW to overseas reprocessing customers.

Appendix B: Alternative Scenarios

Alternative Scenario B

Scenario B is the same as the reference scenario but includes depleted uranium tails from the enrichment of fuel for new build reactors.

Material content (metals dark highlighting, organics light highlighting, other materials no highlighting)

Material	Mass [tonnes]	Material	Mass [tonnes]
Stainless steel	42,300	Resins	3,190
Other ferrous metals	63,000	Hydrocarbons	61
Magnox / magnesium	5,890	Other organics	100
Aluminium (& alloys)	852	Total organics	11,200
Zircaloy / zirconium	8,490	Graphite	65,900
Copper (& alloys)	310	Asbestos	65
Nickel (& alloys)	377	Sludges & flocs	22,100
Uranium	2,040	Cem. Materials	58,600
Lead	490	Ion ex. Resins	3,150
Iron	3,200	Heavy metal oxide	525,000
Other metals	352	Glass, ceramics & sand	3,920
Total metals	127,000	Soil & rubble	1,050
Cellulose	1,060	Other inorganics	7,470
Halogenated plastics	3,300	Total other materials	688,000
Non-hal. Plastics	2,260	Total unspecified	2,210
Rubbers	1,250	Total	828,000

Overall there is a 47% increase in the mass of waste material.

Package numbers and disposal units

Waste Group	Packaged Vol. [m^3]	Disposal Units [-]
SILW / SLLW	87,700	4,780
Legacy UILW	350,000	119,000
RSC	2,590	1,070
DNLEU	360,000	14,900
NB SILW	16,800	7,020
NB UILW	21,500	8,960
HLW	9,370	2,510
Legacy SF	16,600	4,010
NB SF	60,400	13,300
MOX SF	11,700	2,570
Pu	594	196
HEU	103	35
Total	938,000	178,000

There is a: 21.9% increase in the packaged volume and a 3.6% increase in the number of disposal units relative to the reference case. The change is associated with the DNLEU.

Activity [TBq] of priority radionuclides at 2200

C14	26,200	Se79	145	I129	60.2	U233	2.15	U238	5,910
Cl36	192	Kr85	5,060	Cs135	1,260	U235	134	Np237	1,120
Co60	53.5	Tc99	27,900	Cs137	$9.74\ 10^6$				

The total activity at 2200 is $4.69\ 10^7$ TBq with the majority from Cs137 and its short-lived daughter Ba137m (40.4%), Sr90 and its short-lived daughter Y90 (24.4%), Am241 (15.9%), Pu238 (7.37%) and Ni63 (5.22%).

Alternative Scenario C

Scenario C is the same as the reference scenario but assumes a smaller (16 GW(e) new build programme), excludes wastes that have the potential to be suitable for near-surface disposal, assumes potentially suitable wastes are thermally treated, and excludes DNLEU.

Material content (metals dark highlighting, organics light highlighting, other materials no highlighting)

Material	Mass [tonnes]	Material	Mass [tonnes]
Stainless steel	32,500	Resins	2,110
Other ferrous metals	28,200	Hydrocarbons	55
Magnox / magnesium	5,440	Other organics	100
Aluminium (& alloys)	787	Total organics	9,180
Zircaloy / zirconium	6,380	Graphite	65,200
Copper (& alloys)	285	Asbestos	64
Nickel (& alloys)	307	Sludges & flocs	21,400
Uranium	2,030	Cem. Materials	43,900
Lead	482	Ion ex. Resins	2,980
Iron	96	Heavy metal oxide	24,100
Other metals	320	Glass, ceramics & sand	3,820
Total metals	76,800	Soil & rubble	778
Cellulose	990	Other inorganics	7,140
Halogenated plastics	3,210	Total other materials	169,000
Non-hal. Plastics	1,510	Total unspecified	2,040
Rubbers	1,220	Total	257,000

Overall there is a 54.2% decrease in the mass of waste material.

Package numbers and disposal units

Waste Group	Packaged Vol. [m^3]	Disposal Units [-]
SILW / SLLW	75,200	3,980
Legacy UILW	246,000	81,500
RSC	1,590	774
DNLEU	0	0
NB SILW	11,300	4,720
NB UILW	14,500	6,020
HLW	9,370	2,510
Legacy SF	16,600	4,010
NB SF	40,600	8,920
MOX SF	11,700	2,570
Pu	594	196
HEU	103	35
Total	427,000	115,000

There is a: 44.5% reduction in the packaged volume and a 33.1% decrease in the number of disposal units relative to the reference case. The change is associated with the wastes that are no longer assumed to come to a GDF.

Activity [TBq] of priority radionuclides at 2200

C14	20,600	Se79	116	I129	44.5	U233	1.97	U238	274
Cl36	140	Kr85	3,120	Cs135	1,030	U235	11.6	Np237	868
Co60	31.1	Tc99	21,700	Cs137	$6.67\ 10^6$				

The total activity at 2200 is $3.34\ 10^7$ TBq with the majority from Cs137 and its short-lived daughter Ba137m (38.9%), Sr90 and its short-lived daughter Y90 (23.3%), Am241 (17.7%), Pu238 (7.50%) and Ni63 (5.43%).

Container type	Number of Disposal units [-]			Conditioned volume [m^3]		
Scenario	Reference	B	C	Reference	B	C
SILW / SLLW						
2 m box	24	24	24	117	117	117
4 m box	3,800	3,800	3,450	63,000	63,000	59,000
6 m^3 concrete box	962	962	510	5,530	5,530	2,940
UILW / ULLW						
3 m^3 box (side lifting)	18,700	18,700	23,300	52,000	52,000	64,400
3 m^3 box (corner lifting)	53,800	53,800	31,600	129,000	129,000	72,900
3 m^3 drum	76	76	76	167	167	167
500 l drum	44,500	44,500	24,800	85,400	85,400	46,100
Beta-gamma box	1,860	1,860	1,780	6,480	6,480	6,230
Robust shielded containers						
3 m^3 RS box	779	779	635	314	314	253
500 l RS drum	288	288	139	710	710	333
DNLEU						
500 l drum	2,170	2,170	0	4,080	4,080	0
TDC (2.1 m ht)	460	460	0	8,630	8,630	0
TDC (2.3 m ht)	4,510	10,600	0	89,500	210,000	0
TDC (2.4 m ht)	1,700	1,700	0	37,200	37, 200	0
New build SILW						
1 m^3 concrete drum	6,860	6,860	4,610	4,240	4,240	2,850
4 m box	153	153	103	2,180	2,180	1,470
New build UILW						
500 l drum	7,880	7,880	5,300	14,800	14,800	9,950
3 m^3 box (side-lifting)	1,080	1,080	728	2,880	2,880	1,940
HLW						
HLW disposal container	2,510	2,510	2,510	1,470	1,470	1,470
Legacy SF						
AGR disposal container	2,240	2,240	2,240	1,980	1,980	1,980

Container type	Number of Disposal units [-]			Conditioned volume [m^3]		
Magnox disposal container	1,170	1,170	1,170	1,400	1,400	1,400
PFR disposal container	17	17	17	9.94	9.94	9.94
PWR disposal container	586	586	586	436	436	436
New build SF						
New build disposal container	13,300	13,300	8,920	8,740	8,740	5,870
MOX spent fuel						
MOX disposal container	2,570	2,570	2,570	566	566	566
Plutonium						
Pu / HEU disposal container	196	196	196	174	174	174
Highly enriched uranium						
Pu / HEU disposal container	35	35	35	30.3	30.3	30.3

	Material	Reference	Scenario B	Scenario C
Metals	Stainless steel	42,300	42,300	32,500
	Other ferrous metals	44,900	63,00	28,200
	Magnox / magnesium	5,890	5,89	5,440
	Aluminium (& alloys)	852	852	787
	Zircaloy / zirconium	8,490	8,490	6,380
	Copper (& alloys)	310	310	285
	Nickel (& alloys)	377	377	307
	Uranium	2,040	2,040	2,030
	Lead	490	490	482
	Iron	3,200	3,200	96
	Other metals	352	352	320
	Total metals	109,000	127,000	76,800
Organics	Cellulose	1,060	1,060	990
	Halogenated plastics	3,300	3,300	3,210
	Non-halogenated Plastics	2,260	2,260	1,510
	Rubbers	1,250	1,250	1,220
	Resins	3,190	3,190	2,110
	Hydrocarbons	61	61	55
	Other organics	100	100	100
	Total organics	11,200	11,200	9,180
Others	Graphite	65,900	65,900	65,200
	Asbestos	65	65	64
	Sludges & flocs	22,100	22,100	21,400
	Cem. Materials	58,600	58,600	43,900
	Ion ex. Resins	3,150	3,150	2,980
	Heavy metal oxide	277,000	525,000	24,100
	Glass, ceramics & sand	3,920	3,920	3,820
	Soil & rubble	1,050	1,050	778
	Other inorganics	7,470	7,470	7,140
	Total other materials	439,000	688,000	169,000
	Total unspecified	2,210	2,210	2,040
	Total	562,000	828,000	257,000

Appendix C: Waste materials

Table 11 Materials associated with the wastes in each LHGW waste group

	Material	UILW / ULLW	SILW / SLLW	RSC	DNLEU	NB UILW	NB SILW
Metals	Aluminium	824	24.3	1.25	0	0	0
	Copper (and alloys)	294	15.5	0.758	0	0	0
	Iron	91.2	3,100	0.0290	0	0	0
	Lead	477	3.06	5.72	0	3.87	0
	Magnox / Magnesium	5,410	326	35.7	0	0	0
	Nickel (and alloys)	88.4	33.5	2.93	0	1.91	0
	Other ferrous metals	15,900	13,300	457	14,500	9.15	0
	Stainless Steel	19,300	3,630	138	3,920	9,800	3,130
	Uranium	1,000	0.082	0.257	0	0	0
	Zircaloy / Zirconium	1,280	41.1	5.04	0	0	0
	Other Metals	324	26.4	0.741	0	0.924	0
	Total Metals	45,000	20,500	648	18,400	9,820	3,130
Org.	Cellulose	927	16	4.45	0	110	0
	Halogenated Plastics	3,110	3.38	3.55	0	183	0

	Material	UILW / ULLW	SILW / SLLW	RSC	DNLEU	NB UILW	NB SILW
Organics	Hydrocarbons	55.2	0	5.26	0	0	0
	Non-Halogenated Plastics Total	792	290	4.72	83.2	1,090	0
	Organic ion exchange resins	80.9	162	119	0	0	2,830
	Rubber Total	1,190	0.791	1.17	0	57.3	0
	Other Organics	95.3	2.80	2.21	0	0	0
	Total Organics	6,260	475	140	83.2	1,440	2,830
Others	Asbestos	64	0.300	0.502	0	0	0
	Cementitious material	56,900	1,670	1.25	0	0	0
	Glass, Ceramics, Sand	713	12.1	82.7	0	77.3	0
	Graphite	13,200	52,400	219	0	0	0
	Heavy Metal Oxide	0	0	0	245,000	0	0
	Ion exchange resins	2,940	170	40.8	0	0	0
	Sludges & Flocs	20,100	37.6	190	0	1,760	0
	Soil, brick, stone, rubble	806	70.8	165	0	9.15	0
	Other inorganics	6,660	229	44.2	0	530	0
	Total Oher	101,000	54,600	743	245,000	2,370	0
	Unspecified	2,020	174	27.4	-1.85	-6.71	0

Table 12 The materials associated with the container, conditioning matrix and capping grout for LHGW waste groups

	Material	UILW / ULLW	SILW / SLLW	RSC	DNLEU	NB UILW	NB SILW
Container	Stainless steel	19,100	102,000	0	763	4,910	44,500
	Carbon steel	673	3,710	0	10,800	0	0
	Concrete	22,500	47,600	0	1,910	0	0
	Reinforced concrete	9,890	0	0	17,100	0	0
	Magnetite concrete	5,490	0	0	0	0	0
	Cast iron	0	0	9,730	0	0	0
Conditioning	OPC	3,590	47,600	0	585	3,470	13,000
	Water	5,860	77,800	0	955	5,670	19,700
	BFS / PFA	10,800	143,000	0	1,750	10,400	35,100
	Stainless steel	0	0	0	0	0	86.9
	Polymer	310	0	0	1,500	0	0
Capping	OPC	0	7,490	0	0	478	166
	Water	0	5,250	0	0	335	116
	PFA	0	22,500	0	0	1,430	499
	Iron shot concrete	20,000	0	0	688	0	0

Table 13 The waste materials in the HHGW waste groups

		HEU	HLW	Legacy SF	MOX	NB SF	Pu
Metals	Aluminium	0	0	2.60	0	0	0
	Lead	0	0	0.510	0	0	0
	Magnox / Magnesium	0	0	118	0	0	0
	Nickel (and alloys)	0	69.0	11.0	11.0	159	0
	Other ferrous metals	0	0	748	0	0	0
	Stainless Steel	0	645	1,140	38.0	597	0
	Uranium	0	0	1,040	0	0	0
	Zircaloy / Zirconium	0	0	306	417	6,440	0
	Total Metals	0	714	3,360	466	7,200	0
Others	Cementitious material	0	0	0.890	0	0	0
	Glass, Ceramics, Sand	0	2,930	59.0	1.5	40	0
	Graphite	0	0	3.70	0	0	0
	Heavy Metal Oxide	1.10	0	6,480	1,580	23,800	6.50
	Total Other	1.10	2,930	6,540	1,580	23,800	6.50
	Unspecified	0	0	0.0000071	-0.000062	0	0

Table 14 The materials associated with the containers and conditioning for HHGW waste groups

Material	HEU	HLW	Legacy SF	MOX	NB SF	Pu
Containers (if carbon steel)						
Carbon steel	431	41,600	75,000	45,900	243,000	2,410
Containers (if copper)						
Carbon steel	79.6	0	0	0	0	458
Copper	44.7	0	0	0	0	257
Cast iron	8.58	0	0	0	0	0
Conditioning						
Stainless steel	0	2,660	706	0	0	0
Glass	212	18,600	31,100	21,200	109,000	1,220
Ceramic	376	39,500	62,500	60,000	264,000	2,160

Appendix D: Materials from GDF construction and operation

Table 15 Estimated material masses associated with GDF construction in a higher strength host rock[18]

Material	Material Mass [t]								
	HHGW disposal tunnel	UILW Vault	RS ILW Vault	NB SILW Vault	SILW Vault	LLW Vault	DNLEU Vault	Shaft and Drift	Common Service Areas
Aluminium (and alloys)	0	$5.25\ 10^{-2}$	$5.25\ 10^{-2}$	$5.25\ 10^{-2}$	$5.25\ 10^{-2}$	$5.25\ 10^{-2}$	$5.25\ 10^{-2}$	0	0
Bentonite	26,800	0	0	0	0	0	0	0	0
Cementitious material	1,940	91,500	24,100	89,600	77,900	77,900	77,900	103,000	19,200
Copper (and alloys)	0	$4.73\ 10^{-3}$	$4.73\ 10^{-3}$	$4.73\ 10^{-3}$	$4.73\ 10^{-3}$	$4.73\ 10^{-3}$	$4.73\ 10^{-3}$	0	0
Glass / ceramic	0	$1.55\ 10^{-3}$	$1.55\ 10^{-3}$	$1.55\ 10^{-3}$	$1.55\ 10^{-3}$	$1.55\ 10^{-3}$	$1.55\ 10^{-3}$	0	0
Halogenated plastics	0	0.157	0.157	0.157	0.157	0.157	0.157	0	0
Other Ferrous metals	0	42.4	42.4	42.4	23.8	16.3	16.3	0	0
Other organics	0.457	0.905	0.802	0.802	0.802	0.802	0.802	0	7.41
Stainless steel	10.5	41.5	40.5	41.1	33.3	33.3	33.3	506	166
Zinc	0	0.168	0.168	0.168	0.168	0	0	0	0

[18] For tunnels and vaults, the masses are presented for a single unit; they need to be multiplied by the appropriate number of tunnels / vaults. The 'shaft and drift' and 'common service areas' are an estimated total for the GDF.

Table 16 Estimated material masses associated with GDF construction in a lower strength sedimentary host rock[19]

Material	Material Mass [t]								
	HHGW disposal tunnel	UILW Vault	RS ILW Vault	NB SILW Vault	SILW Vault	LLW Vault	DNLEU Vault	Shaft and Drift	Common Service Areas
Aluminium (and alloys)	0	$5.25\ 10^{-2}$	$5.25\ 10^{-2}$	$5.25\ 10^{-2}$	$5.25\ 10^{-2}$	$5.25\ 10^{-2}$	$5.25\ 10^{-2}$	0	0
Bentonite	26,800	0	0	0	0	0	0	0	0
Cementitious material	157	31,300	31,300	36,000	36,800	8,130	36,500	108,000	11,400
Copper (and alloys)	0	$4.73\ 10^{-3}$	$4.73\ 10^{-3}$	$4.73\ 10^{-3}$	$4.73\ 10^{-3}$	$4.73\ 10^{-3}$	$4.73\ 10^{-3}$	0	0
Glass / ceramic	0	$1.55\ 10^{-3}$	$1.55\ 10^{-3}$	$1.55\ 10^{-3}$	$1.55\ 10^{-3}$	$1.55\ 10^{-3}$	$1.55\ 10^{-3}$	0	0
Halogenated plastics	0	0.157	0.157	0.157	0.157	0.157	0.157	0	0
Other Ferrous metals	38.3	19.3	37.9	37.9	30.4	11.8	11.8	0	0
Other organics	1.35	1.92	1.69	1.69	1.82	1.82	1.82	0	10.0
Stainless steel	10.1	38.6	38.5	38.5	31.5	31.5	31.5	643	95.0
Zinc	0	0.168	0.168	0.168	0	0	0	0	0

[19] For tunnels and vaults, the masses are presented for a single unit; they need to be multiplied by the appropriate number of tunnels / vaults. The 'shaft and drift' and 'common service areas' are an estimated total for the GDF.

Table 17 Estimated material masses associated with GDF construction in an evaporite host rock[20]

Material	**Material Mass [t]**								
	HHGW disposal tunnel	**UILW Vault**	**RS ILW Vault**	**NB SILW Vault**	**SILW Vault**	**LLW Vault**	**DNLEU Vault**	**Shaft and Drift**	**Common Service Areas**
Aluminium (and alloys)	0	$5.25\ 10^{-2}$	$5.25\ 10^{-2}$	$5.25\ 10^{-2}$	$5.25\ 10^{-2}$	$5.25\ 10^{-2}$	$5.25\ 10^{-2}$	0	0
Cementitious material	317	962	962	962	1,060	1,060	1,060	85,800	7,700
Copper (and alloys)	$1.68\ 10^{-3}$	$4.73\ 10^{-3}$	$4.73\ 10^{-3}$	$4.73\ 10^{-3}$	$4.73\ 10^{-3}$	$4.73\ 10^{-3}$	$4.73\ 10^{-3}$	0	0
Glass / ceramic	0	$1.55\ 10^{-3}$	$1.55\ 10^{-3}$	$1.55\ 10^{-3}$	$1.55\ 10^{-3}$	$1.55\ 10^{-3}$	$1.55\ 10^{-3}$	0	0
Halogenated plastics	$2.54\ 10^{-2}$	0.157	0.157	0.157	0.157	0.157	0.157	0	0
Other Ferrous metals	38.3	163	163	163	$4.20\ 10^{-3}$	$4.20\ 10^{-3}$	$4.20\ 10^{-3}$	0	0
Other inorganics	0	1,700	929	1,830	3,290	0	2,960	0	0
Other organics	1.96	2.91	2.66	0	0	0	0	0	0
Stainless steel	20.5	36.4	34.7	34.4	36.4	36.4	33.8	101	1,190

[20] For tunnels and vaults, the masses are presented for a single unit; they need to be multiplied by the appropriate number of tunnels / vaults. The ‘shaft and drift’ and ‘common service areas’ are an estimated total for the GDF.

Appendix E: Elemental compositions

The estimated elemental compsition of the 2022 IGD is presented in Table 18; this composition covers the waste, conditioning and capping materials, as well as container materials for all waste groups.

Where no data were available for specific elements (most often minor components), the reported concentrations of these in the Earth's crust have been used as a basis for calculation. Upper uncertainty estimates are reported as 100 times the Earth's crustal abundance, but with a set maximum value (typically 1,000 ppm). In these cases, the lower uncertainty estimates are reported as the upper uncertainty values divided by 100. The mean material compositions have not been enhanced by the addition of Earth's crustal abundance data because it is more than likely that to do so would significantly overestimate the mass of many minor elemental components. This can lead to the best estimate value for an element in the elemental composition tables being less than the value for the lower uncertainty.

Table 18 Elemental composition for all waste groups (waste, conditioning, capping, and container materials). Priority metallic species are highlighted.

Element	Mass [tonnes]				Element	Mass [tonnes]			
	Mean	Upper bound	Lower bound	50th %ile		Mean	Upper Bound	Lower Bound	50th %ile
H	$1.78\ 10^{4}$	$1.98\ 10^{4}$	$1.70\ 10^{4}$	$1.78\ 10^{4}$	Cd	$4.46\ 10^{1}$	$4.79\ 10^{1}$	$4.24\ 10^{1}$	$4.42\ 10^{1}$
He	$6.53\ 10^{-1}$	$6.78\ 10^{-1}$	$6.53\ 10^{-1}$	$6.53\ 10^{-1}$	In	$1.33\ 10^{0}$	$1.50\ 10^{0}$	$1.29\ 10^{0}$	$1.32\ 10^{0}$
Li	$4.86\ 10^{1}$	$5.22\ 10^{1}$	$4.71\ 10^{1}$	$4.85\ 10^{1}$	Sn	$2.59\ 10^{2}$	$3.54\ 10^{2}$	$1.98\ 10^{2}$	$2.49\ 10^{2}$
Be	$2.73\ 10^{1}$	$2.30\ 10^{2}$	$2.85\ 10^{1}$	$2.73\ 10^{1}$	Sb	$6.81\ 10^{1}$	$1.22\ 10^{2}$	$2.49\ 10^{1}$	$6.54\ 10^{1}$
B	$3.89\ 10^{2}$	$5.44\ 10^{2}$	$2.50\ 10^{2}$	$3.86\ 10^{2}$	Te	$2.14\ 10^{1}$	$2.15\ 10^{1}$	$2.14\ 10^{1}$	$2.14\ 10^{1}$
C	$7.80\ 10^{4}$	$8.22\ 10^{4}$	$7.75\ 10^{4}$	$7.80\ 10^{4}$	I	$9.10\ 10^{0}$	$4.52\ 10^{1}$	$9.39\ 10^{0}$	$9.10\ 10^{0}$
N	$2.35\ 10^{2}$	$3.40\ 10^{2}$	$1.64\ 10^{2}$	$2.24\ 10^{2}$	Xe	$2.39\ 10^{2}$	$2.40\ 10^{2}$	$2.39\ 10^{2}$	$2.39\ 10^{2}$
O	$3.69\ 10^{5}$	$3.75\ 10^{5}$	$3.66\ 10^{5}$	$3.69\ 10^{5}$	Cs	$6.96\ 10^{1}$	$7.20\ 10^{1}$	$6.91\ 10^{1}$	$6.96\ 10^{1}$
F	$1.13\ 10^{3}$	$3.79\ 10^{3}$	$1.07\ 10^{3}$	$1.13\ 10^{3}$	Ba	$6.94\ 10^{2}$	$1.69\ 10^{3}$	$5.18\ 10^{2}$	$6.61\ 10^{2}$
Ne	$9.75\ 10^{-1}$	$1.01\ 10^{1}$	$1.02\ 10^{-1}$	$9.75\ 10^{-1}$	La	$6.86\ 10^{1}$	$8.29\ 10^{1}$	$6.70\ 10^{1}$	$6.86\ 10^{1}$
Na	$4.22\ 10^{3}$	$5.53\ 10^{3}$	$3.25\ 10^{3}$	$4.22\ 10^{3}$	Ce	$2.15\ 10^{2}$	$3.52\ 10^{2}$	$1.58\ 10^{2}$	$2.04\ 10^{2}$
Mg	$1.90\ 10^{4}$	$1.96\ 10^{4}$	$1.87\ 10^{4}$	$1.90\ 10^{4}$	Pr	$5.41\ 10^{1}$	$7.20\ 10^{2}$	$5.94\ 10^{1}$	$5.41\ 10^{1}$
Al	$3.18\ 10^{4}$	$3.58\ 10^{4}$	$2.87\ 10^{4}$	$3.18\ 10^{4}$	Nd	$1.97\ 10^{2}$	$2.02\ 10^{2}$	$1.96\ 10^{2}$	$1.97\ 10^{2}$
Si	$9.15\ 10^{4}$	$1.17\ 10^{5}$	$6.48\ 10^{4}$	$9.03\ 10^{4}$	Sm	$3.92\ 10^{1}$	$4.21\ 10^{1}$	$3.89\ 10^{1}$	$3.92\ 10^{1}$
P	$1.44\ 10^{3}$	$2.61\ 10^{3}$	$3.89\ 10^{2}$	$1.20\ 10^{3}$	Eu	$6.67\ 10^{0}$	$7.17\ 10^{0}$	$6.55\ 10^{0}$	$6.67\ 10^{0}$

S	1.62 10^{3}	2.01 10^{3}	1.34 10^{3}	1.60 10^{3}	Gd	1.43 10^{1}	3.46 10^{1}	1.36 10^{1}	1.43 10^{1}
Cl	2.10 10^{3}	2.15 10^{3}	2.09 10^{3}	2.10 10^{3}	Tb	8.31 10^{-1}	6.03 10^{0}	5.28 10^{-1}	8.31 10^{-1}
Ar	1.11 10^{0}	7.07 10^{2}	7.79 10^{0}	1.11 10^{0}	Dy	2.55 10^{0}	5.09 10^{0}	2.06 10^{0}	2.47 10^{0}
K	5.43 10^{3}	7.47 10^{3}	4.46 10^{3}	5.43 10^{3}	Ho	5.84 10^{-1}	2.17 10^{0}	4.52 10^{-1}	5.50 10^{-1}
Ca	9.60 10^{4}	1.21 10^{5}	8.40 10^{4}	9.60 10^{4}	Er	2.36 10^{0}	3.37 10^{0}	1.09 10^{0}	2.29 10^{0}
Sc	9.91 10^{0}	2.30 10^{1}	9.42 10^{0}	9.89 10^{0}	Tm	1.05 10^{0}	4.20 10^{0}	3.40 10^{-1}	8.40 10^{-1}
Ti	2.52 10^{3}	3.79 10^{3}	2.08 10^{3}	2.43 10^{3}	Yb	1.58 10^{0}	6.94 10^{0}	1.15 10^{0}	1.47 10^{0}
V	2.28 10^{2}	4.66 10^{2}	1.09 10^{2}	2.04 10^{2}	Lu	4.17 10^{-1}	1.05 10^{0}	2.57 10^{-1}	3.60 10^{-1}
Cr	4.02 10^{4}	4.34 10^{4}	3.75 10^{4}	4.01 10^{4}	Hf	7.75 10^{0}	9.36 10^{0}	7.27 10^{0}	7.68 10^{0}
Mn	7.49 10^{3}	1.11 10^{4}	4.80 10^{3}	7.22 10^{3}	Ta	5.93 10^{0}	2.06 10^{1}	3.27 10^{0}	5.72 10^{0}
Fe	6.56 10^{5}	6.92 10^{5}	6.46 10^{5}	6.56 10^{5}	W	6.04 10^{1}	1.51 10^{2}	1.59 10^{1}	4.69 10^{1}
Co	3.26 10^{2}	7.86 10^{2}	9.49 10^{1}	2.60 10^{2}	Re	1.75 10^{-2}	1.46 10^{-1}	2.41 10^{-3}	1.58 10^{-2}
Ni	2.63 10^{4}	2.96 10^{4}	2.37 10^{4}	2.62 10^{4}	Os	2.14 10^{-2}	7.56 10^{-2}	5.43 10^{-3}	1.86 10^{-2}
Cu	2.50 10^{3}	4.22 10^{3}	1.45 10^{3}	2.30 10^{3}	Ir	1.04 10^{0}	1.87 10^{0}	7.48 10^{-1}	8.63 10^{-1}
Zn	2.72 10^{2}	5.66 10^{2}	1.58 10^{2}	2.24 10^{2}	Pt	1.41 10^{-2}	4.72 10^{-1}	1.25 10^{-2}	1.37 10^{-2}
Ga	5.74 10^{1}	1.89 10^{2}	1.17 10^{1}	3.62 10^{1}	Au	1.73 10^{1}	1.76 10^{1}	1.73 10^{1}	1.73 10^{1}
Ge	6.69 10^{-1}	1.16 10^{2}	1.60 10^{0}	6.68 10^{-1}	Hg	3.34 10^{-2}	6.96 10^{0}	9.17 10^{-2}	3.34 10^{-2}
As	1.13 10^{2}	2.71 10^{2}	4.77 10^{1}	8.68 10^{1}	Tl	3.27 10^{-1}	6.70 10^{1}	8.78 10^{-1}	3.25 10^{-1}
Se	8.62 10^{0}	2.15 10^{1}	3.24 10^{0}	6.35 10^{0}	Pb	7.25 10^{2}	8.76 10^{2}	6.57 10^{2}	7.15 10^{2}
Br	2.77 10^{0}	1.48 10^{1}	2.12 10^{0}	2.52 10^{0}	Bi	6.99 10^{-2}	6.75 10^{-1}	1.81 10^{-2}	6.60 10^{-2}
Kr	1.54 10^{1}	1.80 10^{1}	1.52 10^{1}	1.54 10^{1}	Po	3.15 10^{-1}	2.89 10^{0}	2.79 10^{-2}	3.15 10^{-1}
Rb	5.58 10^{1}	9.26 10^{1}	4.30 10^{1}	5.30 10^{1}	Rn	8.65 10^{-5}	2.60 10^{-3}	4.33 10^{-6}	8.65 10^{-5}
Sr	1.93 10^{2}	2.65 10^{2}	1.61 10^{2}	1.92 10^{2}	Ra	1.21 10^{-5}	1.38 10^{-5}	1.20 10^{-5}	1.21 10^{-5}
Y	3.87 10^{1}	7.53 10^{1}	3.12 10^{1}	3.52 10^{1}	Ac	5.13 10^{-8}	5.22 10^{-8}	5.12 10^{-8}	5.13 10^{-8}
Zr	8.60 10^{3}	8.65 10^{3}	8.57 10^{3}	8.59 10^{3}	Th	2.04 10^{1}	3.65 10^{1}	1.94 10^{1}	2.02 10^{1}
Nb	1.44 10^{2}	2.33 10^{2}	1.10 10^{2}	1.28 10^{2}	Pa	8.63 10^{-5}	8.88 10^{-5}	8.62 10^{-5}	8.63 10^{-5}
Mo	4.97 10^{3}	6.22 10^{3}	3.95 10^{3}	4.89 10^{3}	U	2.35 10^{5}	2.35 10^{5}	2.35 10^{5}	2.35 10^{5}
Tc	3.14 10^{1}	3.14 10^{1}	3.14 10^{1}	3.14 10^{1}	Np	3.92 10^{1}	3.92 10^{1}	3.92 10^{1}	3.92 10^{1}
Ru	1.03 10^{2}	1.03 10^{2}	1.03 10^{2}	1.03 10^{2}	Pu	3.80 10^{2}	3.80 10^{2}	3.80 10^{2}	3.80 10^{2}
Rh	2.03 10^{1}	3.61 10^{1}	1.87 10^{1}	2.03 10^{1}	Am	4.25 10^{1}	4.25 10^{1}	4.25 10^{1}	4.25 10^{1}

Pd	6.98 10^{1}	7.03 10^{1}	6.92 10^{1}	6.97 10^{1}	Cm	2.15 10^{-1}	2.15 10^{-1}	2.15 10^{-1}	2.15 10^{-1}
Ag	2.15 10^{1}	2.37 10^{1}	2.08 10^{1}	2.13 10^{1}	Cf	4.02 10^{-7}	4.02 10^{-7}	4.02 10^{-7}	4.02 10^{-7}

Appendix F: Gas generation data

Metals geometry data

Mass and geometry information for use in the gas pathway analysis has been prepared using the method detailed in the Underpinning Report [4]. Table 19 shows the total masses, effective plate thicknesses and sphere diameters for all the reactive metals in LHGW; Table 20 and Table 21 show the mass of metals in the waste containers for LHGW and HHGW.

Table 19 Summary of gas generating materials in the LHGW waste streams

Waste group	Material	Total plate mass [tonnes]	Effective plate thickness [m]	Total sphere mass [tonnes]	Effective diameter [m]
Legacy SILW / SLLW	Stainless steel	$3.63\ 10^{3}$	$1.35\ 10^{-2}$	-	-
Legacy UILW / ULLW	Stainless steel	$1.77\ 10^{4}$	$6.89\ 10^{-3}$	$1.58\ 10^{3}$	$1.92\ 10^{-3}$
RSCs	Stainless steel	$1.38\ 10^{2}$	$2.02\ 10^{-2}$	-	-
NB SILW	Stainless steel	$3.13\ 10^{3}$	$2.00\ 10^{-3}$	-	-
NB UILW	Stainless steel	$9.80\ 10^{3}$	$7.35\ 10^{-3}$	-	-
Legacy SILW / SLLW	Mild steel	$1.30\ 10^{4}$	$1.40\ 10^{-2}$	$2.47\ 10^{2}$	$1.57\ 10^{-2}$
Legacy UILW / ULLW	Mild steel	$1.21\ 10^{4}$	$1.04\ 10^{-2}$	$3.80\ 10^{3}$	$6.20\ 10^{-3}$
RSCs	Mild steel	$4.57\ 10^{2}$	$3.00\ 10^{-3}$	-	-
NB SILW	Mild steel	-	-	-	-
NB UILW	Mild steel	$9.15\ 10^{0}$	$5.00\ 10^{-3}$	-	-
Legacy SILW / SLLW	Zircaloy	$4.11\ 10^{1}$	$1.33\ 10^{-2}$	-	-
Legacy UILW / ULLW	Zircaloy	$1.28\ 10^{3}$	$6.03\ 10^{-4}$	-	-
RSCs	Zircaloy	$5.04\ 10^{0}$	$6.03\ 10^{-4}$	-	-
Legacy SILW / SLLW	Aluminium	$2.43\ 10^{1}$	$1.31\ 10^{-3}$	-	-
Legacy UILW / ULLW	Aluminium	$7.12\ 10^{2}$	$1.31\ 10^{-3}$	$1.12\ 10^{2}$	$3.15\ 10^{-3}$
RSCs	Aluminium	$1.25\ 10^{0}$	$1.50\ 10^{-3}$	-	-
Legacy SILW / SLLW	Magnox	$3.26\ 10^{2}$	$1.93\ 10^{-3}$	-	-
Legacy UILW / ULLW	Magnox	$4.21\ 10^{3}$	$5.12\ 10^{-3}$	$1.21\ 10^{3}$	$7.82\ 10^{-4}$
RSCs	Magnox	$3.57\ 10^{1}$	$1.84\ 10^{-3}$	-	-
Legacy SILW / SLLW	Uranium	$8.20\ 10^{-2}$	$9.85\ 10^{-3}$	-	-
Legacy UILW / ULLW	Uranium	$2.99\ 10^{2}$	$9.85\ 10^{-3}$	$7.01\ 10^{2}$	$3.12\ 10^{-3}$
RSCs	Uranium	$2.57\ 10^{-1}$	$9.85\ 10^{-3}$	-	-

Table 20 Summary of gas generating metals in waste containers for LHGW streams

Waste Group	Material	Total mass in plate [tonnes]	Effective plate thickness [m]
Legacy SILW / SLLW	Stainless steel	$1.91\ 10^{4}$	$3.01\ 10^{-3}$
Legacy UILW / ULLW	Stainless steel	$1.32\ 10^{5}$	$5.82\ 10^{-3}$
DNLEU	Stainless steel	$4.59\ 10^{4}$	$3.08\ 10^{-3}$
NB SILW	Stainless steel	$7.63\ 10^{2}$	$3.00\ 10^{-3}$
NB UILW	Stainless steel	$1.02\ 10^{4}$	$5.61\ 10^{-3}$
Legacy SILW / SLLW	Mild steel	$6.73\ 10^{2}$	$2.50\ 10^{-3}$
Legacy UILW / ULLW	Mild steel	$3.71\ 10^{3}$	$6.00\ 10^{-3}$
NB SILW	Mild steel	$1.08\ 10^{4}$	$2.36\ 10^{-2}$
NB UILW	Mild steel	-	-
RSCs	Cast iron	$9.73\ 10^{3}$	$1.35\ 10^{-1}$

Table 21 Summary of gas generating metals in waste containers for HHGW streams

Waste package category	Material	Total mass in plate [tonnes]	Effective plate thickness [m]
HLW	Carbon steel	$3.74\ 10^{4}$	$1.20\ 10^{-1}$
Legacy SF	Carbon steel	$6.71\ 10^{4}$	$1.20\ 10^{-1}$
NB SF	Carbon steel	$2.42\ 10^{5}$	$1.20\ 10^{-1}$
MOX	Carbon steel	$4.59\ 10^{4}$	$1.20\ 10^{-1}$
HEU	Carbon steel	$4.19\ 10^{2}$	$1.20\ 10^{-1}$
Pu	Carbon steel	$2.41\ 10^{3}$	$1.20\ 10^{-1}$

H3 and C14 by material type

The method for deriving H3 and C14 activities associated with different types of material in wastes is presented in the Underpinning Report [4]. The results of the material breakdown analysis are given in Table 22 and Table 23.

Table 22 Activity of H3 associated with materials in waste streams in the 2022 IGD LHGW waste groups

Material component	H3 activity at 2200 [TBq]				
	SILW / SLLW	UILW / ULLW	RSC	NB SILW	NB UILW
Graphite	$9.74\ 10^{-4}$	$2.36\ 10^{-4}$	$2.63\ 10^{-5}$	-	-
Stainless steel	$5.43\ 10^{-4}$	$2.68\ 10^{-2}$	$2.22\ 10^{-5}$	-	-
Other ferrous metals	-	$1.03\ 10^{-1}$	-	-	-
Zircaloy / zirconium	$3.89\ 10^{-6}$	$2.19\ 10^{-3}$	$3.89\ 10^{-6}$	-	-
Nimonic (nickel based) alloys	-	$6.21\ 10^{-2}$	$5.40\ 10^{-6}$	-	-
Magnox alloys	$1.44\ 10^{-6}$	$3.75\ 10^{-3}$	$6.24\ 10^{-4}$	$7.11\ 10^{-3}$	$1.52\ 10^{-3}$
Uranium metal	-	$1.84\ 10^{-3}$	-	-	-
Magnox corrosion products	$4.49\ 10^{-6}$	$8.65\ 10^{-2}$	$4.50\ 10^{-5}$	-	-
U metal corrosion products	$1.08\ 10^{0}$	$9.94\ 10^{-1}$	$1.06\ 10^{-2}$	$1.86\ 10^{0}$	$4.98\ 10^{3}$
Materials from THORP[21]	$9.74\ 10^{-4}$	$2.36\ 10^{-4}$	$2.63\ 10^{-5}$	-	-
Other streams containing H3	$5.43\ 10^{-4}$	$2.68\ 10^{-2}$	$2.22\ 10^{-5}$	-	-
Not assessed	-	$1.03\ 10^{-1}$	-	-	-
Total	$3.89\ 10^{-6}$	$2.19\ 10^{-3}$	$3.89\ 10^{-6}$	-	-

[21] Materials such as desiccant & ion exchange materials and barium carbonate.

Table 23 Activity of C14 associated with materials in waste streams in the 2022 IGD LHGW waste groups

Material component	C14 activity at 2200 [TBq]				
	SILW / SLLW	UILW / ULLW	RSC	NB SILW	NB UILW
Graphite	$6.20\ 10^{3}$	$6.87\ 10^{2}$	$7.34\ 10^{-1}$	-	-
Stainless steel	$9.88\ 10^{1}$	$1.50\ 10^{2}$	$1.47\ 10^{1}$	-	$1.40\ 10^{4}$
Other ferrous metals	$1.30\ 10^{2}$	$5.32\ 10^{1}$	$5.80\ 10^{-1}$	$5.68\ 10^{-1}$	-
Zircaloy / zirconium	$1.14\ 10^{0}$	$9.83\ 10^{-5}$	$6.45\ 10^{-2}$	-	-
Nimonic (nickel based) alloys	$7.21\ 10^{0}$	$4.76\ 10^{1}$	$2.00\ 10^{-1}$	-	-
Magnox alloys	$1.18\ 10^{-1}$	$3.84\ 10^{1}$	$2.73\ 10^{-2}$	-	-
Uranium metal	-	$2.21\ 10^{1}$	-	-	-
Magnox corrosion products	$3.26\ 10^{-3}$	$1.52\ 10^{2}$	$3.26\ 10^{-3}$	-	-
U metal corrosion products	-	$3.60\ 10^{1}$	-	-	-
Materials from THORP[21]	$1.16\ 10^{0}$	$4.58\ 10^{1}$	$3.91\ 10^{0}$	$4.36\ 10^{0}$	$2.01\ 10^{-1}$
Other streams containing C14	-	$1.25\ 10^{1}$	-	-	-
Not assessed	$1.18\ 10^{0}$	$1.35\ 10^{2}$	$7.52\ 10^{-1}$	-	-
Total	$6.44\ 10^{3}$	$1.38\ 10^{3}$	$2.10\ 10^{1}$	$4.93\ 10^{0}$	$1.40\ 10^{4}$

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