Radioactive Waste Management

NDA Report no. DSSC/401/01

Geological Disposal

Generic Disposal System Specification
Part A: High Level Requirements

December 2016

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Preface

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

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

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

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

Executive Summary

Radioactive Waste Management Limited (RWM), a wholly owned subsidiary of the Nuclear Decommissioning Authority (NDA), is responsible for implementing the UK Government's policy on geological disposal of higher activity waste. RWM is being developed into a Site Licence Company responsible for the construction and operation of a geological disposal facility (GDF).

RWM has developed a generic Disposal System Specification (DSS) to describe the requirements on the disposal system which form the basis of RWM's design and assessment work. The DSS comprises two documents:

- Disposal System Specification Part A: High Level Requirements
- Disposal System Specification Part B: Technical Specification

This document is the DSS Part A whose purpose is to document the high level requirements on the disposal system which derive from:

- inventory of waste for disposal
- legislative and regulatory requirements
- stakeholder requirements

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1 Introduction

1.1 The generic Disposal System Safety Case

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

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

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

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

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

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

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

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[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.

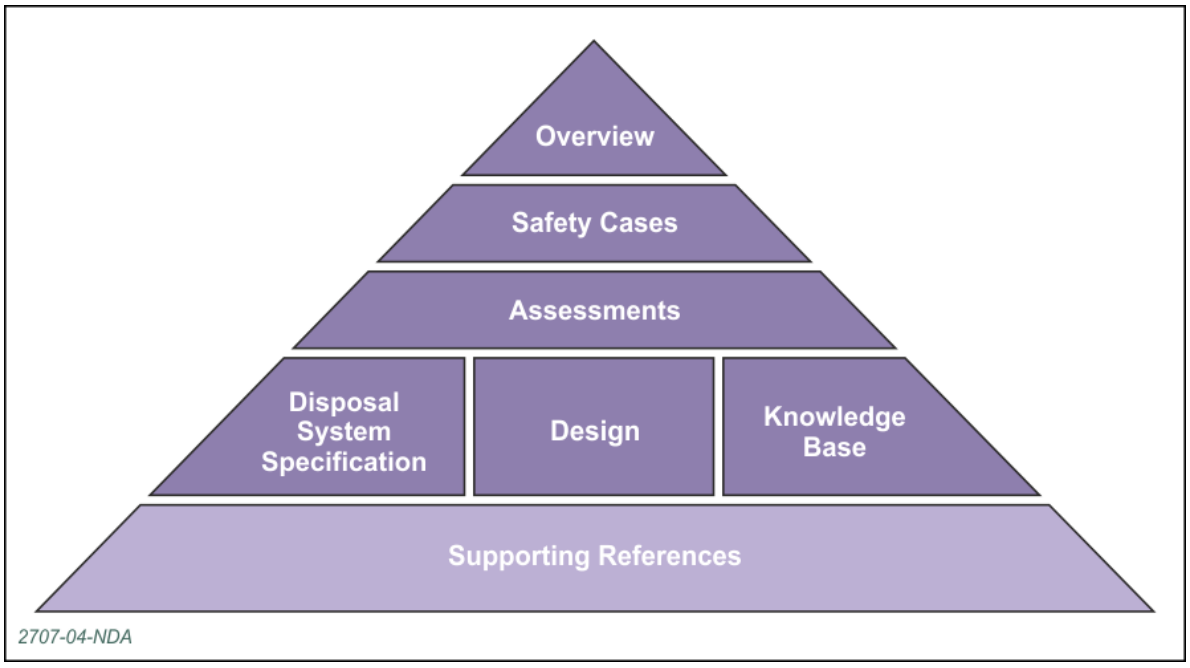
High level information on the inventory for disposal, the illustrative disposal concepts and other aspects of the disposal system is collated in a technical background document (the Technical Background) [3] that supports this generic Disposal System Safety Case.

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

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

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

Figure 1 Structure of the generic DSSC



1.2 Introduction to the Disposal System Specification (DSS)

The disposal system fundamentally needs to; *manage the inventory of higher activity waste for disposal to protect people and the environment, both now and in the future, taking into account; safety, security, safeguards, socioeconomic impacts, and value for money.* This

is achieved through the definition of requirements on organisational management, site selection and evaluation, design of a GDF and its construction, operation and closure.

To meet this fundamental need, requirements are identified on organisational management, site selection and evaluation, design of a GDF and its construction, operation and closure. These requirements are reported in the DSS using two documents:

- **Disposal System Specification Part A: High Level Requirements**

  The high-level external requirements on the disposal system including the activities required to transport, receive and emplace waste packages in a GDF

- **Disposal System Specification Part B: Technical Specification**

  The technical requirements that frame the development of a solution to meet the requirements of Part A

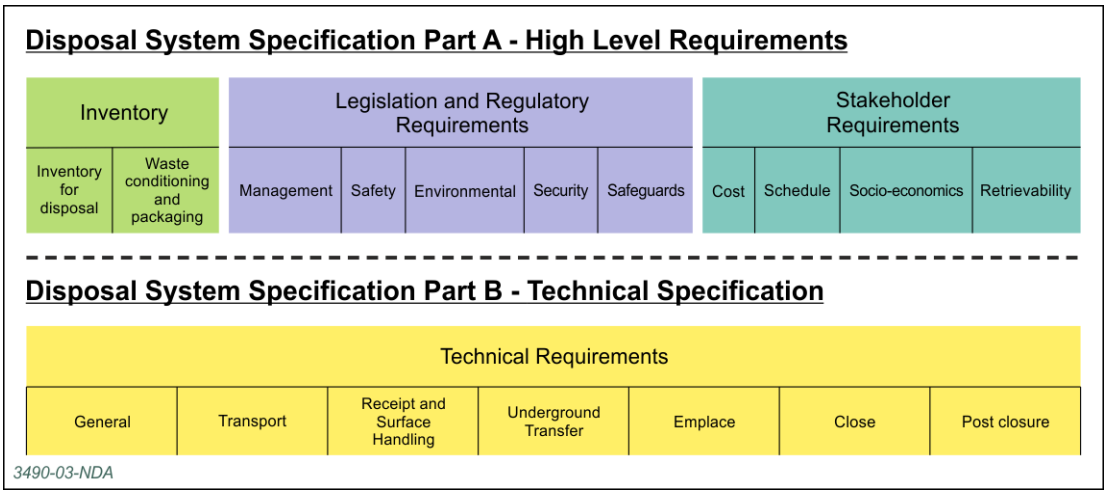
1.3 Objective

The primary objective of the DSS is to provide the designers of the disposal system with the requirements that must be satisfied and therefore defines the scope and bounds of the engineering design work.

1.4 Scope

As stated in Section 1.2, the purpose of Part A is to document the high level requirements on the disposal system. These high level requirements derive from; legislation, regulations, national and international guidance (for example international guidance documents), stakeholder requirements, and the characteristics and quantities of the inventory for disposal as shown in Figure 2.

Figure 2 Structure of the Disposal System Specification



RWM must comply with UK regulatory requirements and these have been used as the primary source of requirements for Part A. Many of the UK regulatory requirements will be imposed by environmental permits and nuclear site licence conditions that have not yet been granted. However, the regulators' existing licensing and permitting practices provide a good indication of the requirements that are likely to be imposed on us and, hence, are currently being used.

There is agreement internationally that geological disposal provides a safe long term management solution for higher activity waste. This is expressed in documents such as the Joint Convention on the Safety of Spent Fuel Management and on the Safety of

Radioactive Waste Management [4] and the Disposal of Radioactive Waste – Specific Safety Requirements from the International Atomic Energy Agency (IAEA) [5].

The IAEA safety series does not form part of the UK's regulatory regimes, although Government and regulators do use them to inform the development and review of their requirements. However, it is important to be able to demonstrate that the UK regulatory requirements are in line with international thinking on ensuring the safety of geological disposal. RWM has therefore decided to treat the IAEA safety requirements for radioactive waste (SSR-5) [5] (but not necessarily all other international guidance that could be relevant) as requirements. If any conflicts are identified between national and international sources, UK regulations and legislation take precedence.

At this early stage it has not been decided who will be responsible for safety whilst waste is being transported. The responsibility for providing a safe transport operation may not lie solely with RWM, but also with other organisations, for example waste consignors or a third-party carrier. The high level requirements included in Part A for transport reside with the consignee and the carrier. In the absence of a carrier, or an organisation to represent the carrier at this early stage, these have been included as requirements in Part A so that any future requirements are not forgotten.

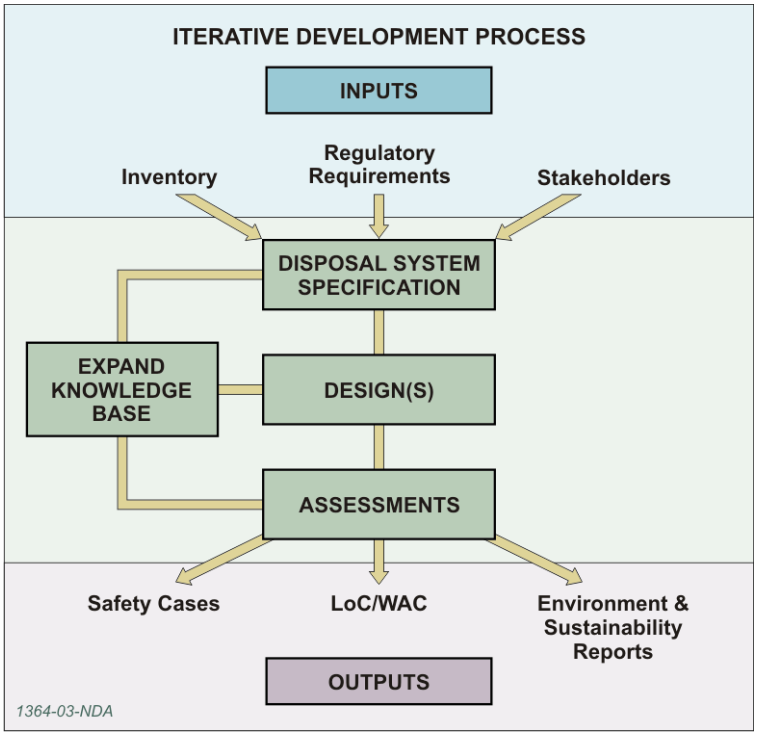
As part of a requirements management approach the high level requirements are used to derive the technical requirements on the disposal system (Part B) for use in disposal system design and assessment at the generic and site-specific stages of the programme (see Figure 2). Some of the high level requirements that have been included in Part A of the DSS are management requirements and as such place requirements on RWM as an organisation rather than technical requirement on the disposal system, hence are addressed in other documents such as RWM Management Systems Manual [6] rather than in Part B.

The DSS is used to support the iterative development of the disposal system as shown in Figure 3. A disposal system design is developed to meet the requirements defined in the DSS as a whole and that design is subject to assessments of its safety and environmental impacts. Information from research and development (R&D) is required to support all these activities and the outputs of the assessments are used to identify where further R&D is required and subsequently documented in the Science and Technology Plan [7].

The high level requirements specified in Part A will not be influenced by any site identified from the GDF siting process. This document will be actively maintained to respond to changes in regulatory requirements and to reflect the most up to date inventory information captured in the 2013 Derived Inventory. The DSS is the basis from which GDF designs are generated, and therefore will respond to future changes in requirements including: new legislation or Government policy, the final allocation of responsibilities and liabilities for activities, and facility requirements (for example decisions on a single facility, retrievability, or packaging plants at a geological disposal facility site).

Part B will initially describe generic requirements reflecting the fact that a site and disposal concepts have yet to be selected. At the current stage there are fewer and higher level requirements, and these would become much more detailed when site-specific information becomes available. Some (for example the illustrative concepts to be used) will be based on assumptions derived from comparisons with designs being implemented internationally. To support the current stage of development, RWM has multiple generic designs and safety cases to cover the range of potential GDF host rocks found in the UK. A generic Part B will be maintained up until final site selection in order to provide a basis for generic designs, safety and environmental assessments and generic Waste Package Specifications will be used to provide packaging advice in order to ensure options are not prematurely foreclosed. Part B will be maintained to respond to improvements in the knowledge base and learning from undertaking generic safety assessments and as issues are resolved.

Figure 3 Iterative Development of the disposal system



As site-specific information becomes available a site-specific Part B will be developed for each site being investigated to support the development of site-specific designs. Detailed site-specific stakeholder requirements (including relevant host community requirements) will be captured in the site-specific Part B document. RWM will work with community representatives to ensure local issues are addressed appropriately and used to inform the site-specific Part B for each potential site.

The assumptions in the site-specific Part B (carried forward from the generic Part B) will be gradually replaced with site-specific requirements based on the outcome of the concept selection process and iterations of the disposal system development process informed by information from site characterisation work. The development of the requirements will be an iterative process based on assessments of safety, environmental effects and cost. The requirements will be continually refined in light of the results from ongoing programmes of work, including design development, assessments and R&D. Updating the DSS will take into account the results from work on inventory, engineering design, site investigations, safety, environmental and sustainability assessment, consideration of security and safeguard requirements, R&D, changes to legislation and regulation and stakeholder engagement.

1.5 Document structure

Section 2 sets out the wastes and nuclear materials to be considered in the design of the disposal system which derive from the 2014 White Paper [2] and the UK Radioactive Waste Inventory (UK RWI) [8].

Section 3 sets out legislation and regulation requirements.

Section 4 sets out RWM's current understanding of stakeholder requirements and how RWM expect further requirements to be identified in the future.

2 Inventory

2.1 Inventory for disposal

The wastes disposed of in a geological disposal facility are determined by relevant policies, and are currently defined in the 2014 White Paper [2].

The 2014 White Paper provides a description of the inventory for disposal - the higher activity waste and other materials that could, possibly, come to be regarded as wastes that may need to be managed in the future through geological disposal.

The inventory for disposal is based on the UK RWI [8]. The UK RWI is the publicly available compilation of data on existing and expected radioactive wastes from historical and ongoing nuclear operations, together with other radioactive materials not currently classified as waste. Changes in the UK RWI will occur. The estimated quantity and the types of waste to be consigned to a disposal facility need to be visible and the UK RWI is regularly updated to ensure transparency and indicate the nature of these changes.

The inventory for disposal includes higher activity waste (HLW, ILW and LLW that cannot be managed under the UK policy for long term management of solid LLW in the UK) and radioactive materials that are not currently classified as waste but that may, if it were decided at some point that they had no further use, need to be managed through geological disposal. The 2014 White Paper defines spent fuel[2], plutonium and uranium as radioactive materials that are not currently classified as a waste but that may need to be managed through geological disposal. RWM therefore factors possible inclusion of all wastes and materials within the inventory for disposal into the design and development of a geological disposal facility. Requirements relating to the inventory for disposal are set out in Table 1.

[2] Except spent fuel from research reactors that is not reprocessed.

Table 1 Inventory for disposal

No.	Requirement	Reference
Waste		
1.1	The disposal system shall be designed to manage: • HLW arising from the reprocessing of spent fuel at Sellafield • ILW arising from existing nuclear licensed sites, and defence, medical, industrial, research and educational activities • the small proportion of LLW that is not suitable for disposal in the national Low Level Waste Repository • ILW from a new build programme up to a defined amount, that is 16 gigawatt electrical (see 1.5 below) • spent fuel from research reactors that is not reprocessed	2014 White Paper Para 2.17 [2]
Nuclear Materials (yet to be declared waste)		
1.2	The disposal system shall be designed to manage: • spent fuel from existing commercial reactors that is not reprocessed • spent fuel from a new build programme up to a defined amount, that is 16 gigawatt electrical (see 1.5 below) • plutonium stocks – residual plutonium not re-used in new fuel manufacture • uranium stocks – including that arising from reprocessing, enrichment and fuel fabrication activities • irradiated fuel and nuclear materials from the UK defence programme	2014 White Paper Para 2.17 [2]
1.3	The disposal system shall be developed using the UK RWI as its source of inventory data.	2014 White Paper Para 2.20 [2]
1.4	The disposal system shall be flexible and robust to changes in waste quantity within the inventory for disposal.	2014 White Paper Para 2.20 [2]
1.5	The current stated industry ambition for new nuclear development is 16 gigawatt electrical.	2014 White Paper Para 7.41 [2]
1.6	The Government's preferred policy for the long-term management of plutonium is that it should be reused in the form of mixed oxide fuel.	2014 White Paper Para 2.15 [2]

2.2 Waste conditioning and packaging

Whilst the precise manner in which geological disposal would be implemented in the UK is not yet defined, it is envisaged that any such approach to the long term management of higher activity waste in this manner would comprise a number of distinct stages. These could include:

- the manufacture of passively safe and disposable waste packages
- a period of interim surface storage, usually at the site of waste arising or packaging
- transport of the waste packages to a GDF
- receipt and emplacement in a GDF
- backfilling of the disposal areas and
- eventual sealing and closure of the facility

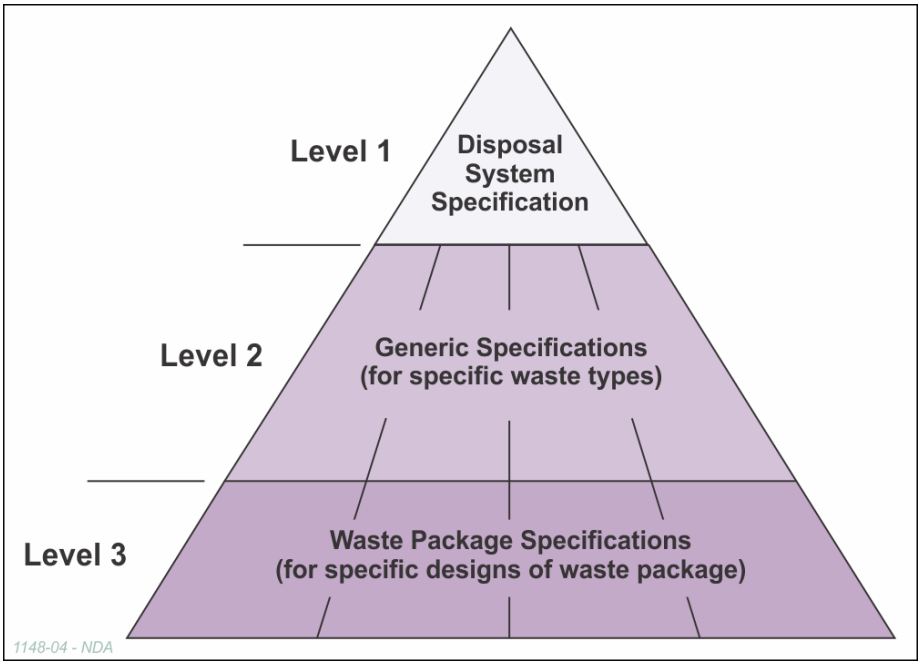
The exact nature, timing and duration of each stage would depend on a number of criteria including the geographical location and host geological environment of a GDF, as well as the disposal concept selected for implementation for each distinct type of waste.

RWM has defined generic waste package requirements in Part B [9] which are derived from full consideration of all future phases of waste management. The requirements are defined so that they would be bounding of the eventual Waste Acceptance Criteria (WAC) for an operational GDF and as such the generic requirement for waste packages act as preliminary WAC.

The generic waste package requirements set out in Part B define requirements for waste packages containing any type of radioactive waste which could be subject to geological disposal. These are the highest level requirement in a hierarchy of packaging specifications as illustrated in Figure 4. Level 2 specifications are then developed by the RWM Waste Management department in response to the Level 1 requirements in Part B.

The hierarchy comprises three ‘levels’ of packaging specification in which each successive level represents an increasing degree of specificity, both to the nature of the waste and the design of the waste package.

Figure 4 Hierarchy of the RWM packaging specifications



Waste owners shall have responsibility for packaging waste in compliance with the appropriate waste package specification or WAC. RWM has established the Disposability Assessment process [10] which is used to support the UK nuclear industry's ongoing work on the conditioning and packaging of higher activity wastes for eventual disposal in a GDF. The process is designed to evaluate the properties of proposed waste packages and to assess their safety performance, to determine whether they are likely to be disposable. The compliance of proposed waste packages with all of the generic requirements is signified by the issue of a LoC which indicates RWM's endorsement of the disposability of that specific design of waste package. The issue of a LoC gives the waste producer confidence that the waste package has been assessed by an independent waste management organisation in accordance with procedures that are scrutinised by the regulators. It does not remove the need for assessment of the waste package against future WAC but reduces the risk that waste packages manufactured in advance of the eventual agreed WAC for the GDF will need to be repackaged in the future.

3 Legislative and Regulatory Requirements

As stated in Section 1, geological disposal involves isolating radioactive waste in packages deep underground inside a suitable rock volume to ensure that no harmful quantities of radioactivity ever reach the surface environment. In the UK, the depth of disposal assumed is that recommended by CoRWM in its recommendations to Government in 2006, that is 'between 200 metres and one kilometre underground' [11].

3.1 Regulatory framework

As the developer of a GDF, RWM is responsible for safety, security, and environmental protection throughout the lifetime of the programme. RWM is responsible for complying with all the regulatory requirements on geological disposal. At present RWM is subject to voluntary scrutiny by the Environment Agency, Office for Nuclear Regulation (ONR) and Department for Transport in readiness for future permitting and site licensing [12].

International (IAEA) radiological and nuclear safety principles and guidance [13,14] are generally integrated into UK legislation, either directly or via the implementation of European Union (EU) Council Directives. UK legislation also takes account of guidance from the International Commission on Radiological Protection (ICRP) [15], via advice from Public Health England (PHE)[3] [16].

A co-ordinated programme of work will be implemented as part of a staged application and approval process to ensure that the necessary permissions are obtained. A Permissions Schedule [17] for geological disposal has been developed by RWM in consultation with the regulators. It sets out how obtaining land-use planning permissions (and the environmental assessments that support them) can be co-ordinated with the processes involved in being granted and operating under a nuclear site licence, environmental permits, and other permissions that will be needed for the successful implementation of geological disposal. Co-ordination of the regulatory processes as set out in the Permissions Schedule will help to ensure early and continuous scrutiny of the geological disposal programme.

The programme of work conducted to meet the Permissions Schedule shall be in accordance with RWM's Health, Safety, Security and Environmental (HSSE) policy statement [18].

3.2 Identification of legislative and regulatory requirements

Compliance with the relevant regulatory requirements is required to ensure the health and safety of employees, contractors and the public, and the protection of the environment in the development of the disposal system. As explained in Section 1.4, many UK regulatory requirements will be imposed by environmental permits and nuclear site license conditions that have yet to be granted under the:

- **Nuclear Installations Act 1965 (NIA 65) [19]**

  A geological disposal facility will require a Nuclear Site Licence under NIA 65, with the Health and Safety at Work Act (HSWA) 74 [20] providing the principal health and safety legislation. The Office for Nuclear Regulation (ONR) is responsible for regulating the safety of nuclear installations in Great Britain [21]. ONR has the power to grant nuclear site licences subject to such conditions as it considers necessary for the safe operation of the installation.

[3] The Health Protection Agency (HPA) is now part of Public Health England (PHE), an executive agency of the Department of Health (DoH).

- **Environmental Permitting (England and Wales) Regulations (EPR 10) [22]**

  This provides a framework for the regulation of activities associated with the disposal of radioactive waste in England and Wales. The disposal of solid, liquid or gaseous radioactive waste in England or Wales must be authorised by a permit granted by the Environment Agency or Natural Resources Wales (respectively) and must be carried out in accordance with any conditions attached to the permit by the relevant agency for the purposes of protecting the public and environment. A permit is also required for intrusive investigation work or other excavation, construction or building work carried out to determine the suitability of a site, or enable a site to be used for underground disposal of radioactive waste. In effect, this establishes a requirement for staged regulation of the implementation process, commencing when boreholes are drilled as part of surface-based investigations. The disposal of radioactive waste in Northern Ireland is regulated under the Radioactive Substances Act 1993 (RSA 93) [23] by the Northern Ireland Environment Agency (NIEA).

Existing regulatory licensing and permitting guidance provides a good indication of the requirements that are likely to be imposed on RWM along with international standards which provide a basis for adopting best practise.

To identify the requirements documented in Sections 3.3 to 3.7 a structured review of the following documentation was conducted and the requirements (extracted verbatim[4]) were allocated into the respective Tables 7 to 14:

- Disposal of Radioactive Waste, Specific Safety Requirements, SSR-5 [5]
- Regulations for the Safe Transport of Radioactive Material, Specific Safety Requirements SSR-6 [24]
- Geological Disposal Facilities on Land for Solid Radioactive Waste, Guidance on Requirements for Authorisation (GRA) [25]
- Radioactive Substances Regulations, Environmental Principles (REPs) [26]
- Safety Assessment Principles for Nuclear Facilities [27]
- Nuclear Industry Security Regulations [28]
- Commission Regulation (Euratom) No 302/2005 [29]
- Joint guidance from the Office of Nuclear Regulation, the Environment Agency, the Scottish Environment Protection Agency and Natural Resources Wales to nuclear licensees [30]

All relevant[5] 'Requirements' from the EA's GRA [25] and 'Fundamental Principles' from the ONR's SAPs [27] are included along with the 'Requirements' from the IAEA's SSR-5. Further, the relevant aspects from the EA REPs [26], the IAEA's SSR-6 [24] and UK/ EU environmental, security and safeguards regulations have also been included.

It should be noted that where a similar requirement exists in both international and domestic guidance, the domestic guidance is quoted and takes precedence, with additional reference made to the international guidance.

RWM has adopted the following definitions of *'shall'* and *'should'*:

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4 Requirements not extracted completely verbatim are those related to Transport, Security and Safeguards and the reader is directed to the source reference.

5 There are a small number of 'Requirements' from the specified sources that have not been included since they do not apply to RWM or in the context of the development of the disposal system eg Requirement 1 of SSR-5 relates to responsibilities of the Government [5].

- *'shall'* denotes a limit which is derived from consideration of a regulatory requirement
- *'should'* denotes a target, and from which relaxations may be possible if they can be shown not to result in any significant reduction in the overall safety of the disposal system

Since the requirements have been extracted verbatim from their source, there is some inconsistency in the use of these terms, therefore RWM has interpreted all uses of *'should'* in these requirements as *'shall'*.

It is further recognised that there is a significant amount of legislation that applies in governing health and safety and therefore the following shall also be taken into consideration in disposal system development:

- The Health and Safety at Work, etc Act 1974 (HSWA 74) [20] HSWA 74 places a general duty on employers to ensure, so far as is reasonably practicable, the health, safety and welfare of all their employees, and that people not in their employment[6] are not exposed to risk. HSWA 74 requires RWM to have a Health and Safety Policy Statement [18] and the organisation and arrangements for carrying out that policy.
- The Management of Health and Safety at Work Regulations 1999 (MHSW) [31]. The MHSW Regulations build on HSWA 74 and implement certain provisions of the European Union Health and Safety Framework Directive [32].
- The Workplace (Health, Safety and Welfare) Regulations 1992 [33].
- The Pressure Systems Safety Regulations (PSSR) which applies to waste packages that have, or are likely to attain a pressure of 0.5 bar greater than atmospheric pressure [34].
- The Ionising Radiations Regulations 1999 (IRR 99) [35]. The principal aim of IRR 99 is to ensure protection of employees and other persons from ionising radiations.
- The Construction (Design and Management) Regulations 2015 (CDM 2015) [36]. The aim of CDM 2015 is to improve health and safety in construction by focussing on effective planning and the management of risk.
- The Control of Major Accident Hazard Regulations (COMAH) 2015 [37] which implements the Seveso III Directive (2012/18/EU) on the control of major accident hazards [38].
- The Radiation (Emergency Preparedness and Public Information Regulations (REPPIR) 2001 [39] which implement (in part) EU Council Directive 96/29/Euratom [40].
- The Conservation of Habitats and Species Regulations 2010 [41] and the EIA Directive 2014/52/EC [42].

Where appropriate, RWM will also adopt safety standards from legislation that do not directly apply to geological disposal to reflect current good practise. An example of this is consideration of UK mining regulations such as The Mines Regulations 2014 [43] and the Mines (Safety of Exit) Regulations [44] in relation to the construction and maintenance of underground workings.

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[6] This includes contractors and sub-contractors as well as the public and visitors.

3.3 High level management requirements

Table 2 sets out the high level management requirements that RWM must meet as the developer of a GDF.

Table 2 High level management requirements

No.	Requirement	Reference
2.1	Responsibilities of the operator. The operator of a disposal facility for radioactive waste shall be responsible for its safety. The operator shall carry out a safety assessment and develop and maintain a safety case, and shall carry out all the necessary activities for site selection and evaluation, design, construction, operation, closure and, if necessary, surveillance after closure, in accordance with national strategy, in compliance with the regulatory requirements and within the legal and regulatory infrastructure.	Requirement 3: IAEA, Disposal of Radioactive Waste, Specific Safety Requirements SSR-5 [5]
2.2	Preparation, approval and use of the safety case and safety assessment for a disposal facility. A safety case and supporting safety assessment shall be prepared and updated by the operator, as necessary, at each step in the development of a disposal facility, in operation and after closure. The safety case and supporting safety assessment shall be submitted to the regulatory body for approval. The safety case and supporting safety assessment shall be sufficiently detailed and comprehensive to provide the necessary technical input for informing the regulatory body and for informing the decisions necessary at each step.	Requirement 12: IAEA, Disposal of Radioactive Waste, Specific Safety Requirements SSR-5 [5]
2.3	Understanding of a disposal facility and confidence in safety. The operator of a disposal facility shall develop an adequate understanding of the features of the facility and its host environment and of the factors that influence its safety after closure over suitably long time periods, so that a sufficient level of confidence in safety can be achieved.	Requirement 6: IAEA, Disposal of Radioactive Waste, Specific Safety Requirements SSR-5 [5]
2.4	Scope of the safety case and safety assessment. The safety case for a disposal facility shall describe all safety relevant aspects of the site, the design of the facility and the managerial control measures and regulatory controls. The safety case and supporting safety assessment shall demonstrate the level of protection of people and the environment provided and shall provide assurance to the regulatory body and other interested parties that safety requirements will be met.	Requirement 13: IAEA, Disposal of Radioactive Waste, Specific Safety Requirements SSR-5 [5]

No.	Requirement	Reference
2.5	Passive means for the safety of the disposal facility. The operator shall evaluate the site and shall design, construct, operate and close the disposal facility in such a way that safety is ensured by passive means to the fullest extent possible and the need for actions to be taken after closure of the facility is minimized.	Requirement 5: IAEA, Disposal of Radioactive Waste, Specific Safety Requirements SSR-5 [5]
2.6	The period after closure and institutional controls. Plans shall be prepared for the period after closure to address institutional control and the arrangements for maintaining the availability of information on the disposal facility. These plans shall be consistent with passive safety features and shall form part of the safety case on which authorization to close the facility is granted.	Requirement 22: IAEA, Disposal of Radioactive Waste, Specific Safety Requirements SSR-5 [5]
2.7	Importance of safety in the process of development and operation of a disposal facility. Throughout the process of development and operation of a disposal facility for radioactive waste, an understanding of the relevance and the implications for safety of the available options for the facility shall be developed by the operator. This is for the purpose of providing an optimized level of safety in the operational stage and after closure.	Requirement 4: IAEA, Disposal of Radioactive Waste, Specific Safety Requirements SSR-5 [5]
2.8	An application under RSA 93[7] relating to a proposed disposal of solid radioactive waste should be supported by an environmental safety case.	Requirement R3: EA, Geological Disposal Facilities on Land for Solid Radioactive Wastes, Guidance on Requirements for Authorisation [25]

[7] Note that the Environmental Permitting Regulations 2010 (EPR 10) now applies in England and Wales instead of RSA 93.

No.	Requirement	Reference
2.9	The developer/ operator of a disposal facility for solid radioactive waste should carry out a programme of site investigation and site characterisation to provide information for the environmental safety case and to support facility design and construction.	Requirement R11: EA, Geological Disposal Facilities on Land for Solid Radioactive Wastes, Guidance on Requirements for Authorisation [25] Requirement 6: IAEA, Disposal of Radioactive Waste, Specific Safety Requirements SSR-5 [5] Requirement 15: IAEA, Disposal of Radioactive Waste, Specific Safety Requirements SSR-5 [5]
2.10	The developer/operator should carry out an assessment to investigate the radiological effects of a disposal facility on the accessible environment, both during the period of authorisation and afterwards, with a view to showing that all aspects of the accessible environment are adequately protected.	Requirement R9: EA, Geological Disposal Facilities on Land for Solid Radioactive Wastes, Guidance on Requirements for Authorisation [25]
2.11	Documentation of the safety case and safety assessment. The safety case and supporting safety assessment for a disposal facility shall be documented to a level of detail and quality sufficient to inform and support the decision to be made at each step and to allow for independent review of the safety case and supporting safety assessment.	Requirement 14: IAEA, Disposal of Radioactive Waste, Specific Safety Requirements SSR-5 [5]
2.12	A management system based on international, national or other standards acceptable to the competent authority shall be established and implemented for all activities within the scope of the (Transport) Regulations to ensure compliance with the relevant provisions of the Regulations.	Paragraph 306: IAEA, Regulations for the Safe Transport of Radioactive Waste, Specific Safety Requirements SSR-6 [24]
2.13	A radiation protection programme shall be established for the transport of radioactive material. The nature and extent of the measures to be employed in the programme shall be related to the magnitude and likelihood of radiation exposures.	Paragraph 302: IAEA, Regulations for the Safe Transport of Radioactive Waste, Specific Safety Requirements SSR-6 [24]
2.14	Responsibility for safety. The prime responsibility for safety must rest with the person or organisation responsible for the facilities and activities that give rise to radiation risks.	Fundamental Principle 1: ONR, Safety Assessment Principles for Nuclear Facilities [27]

No.	Requirement	Reference
2.15	Leadership and management for safety. Effective leadership and management for safety must be established and sustained in organisations concerned with, and facilities and activities that give rise to, radiation risks.	Fundamental Principle 2: ONR, Safety Assessment Principles for Nuclear Facilities [27]
2.16	The developer/ operator of a disposal facility for solid radioactive waste should foster and nurture a positive environmental safety culture at all times and should have a management system, organisational structure and resources sufficient to provide the following functions: (a) planning and control of work; (b) the application of sound science and good engineering practice; (c) provision of information; (d) documentation and record and record-keeping; (e) quality management.	Requirement R4: EA, Geological Disposal Facilities on Land for Solid Radioactive Wastes, Guidance on Requirements for Authorisation [25] Requirement 25: IAEA, Disposal of Radioactive Waste, Specific Safety Requirements SSR-5 [5] NDA, Client Specification, RWM, ref 1.2f [55]
2.17	The developer should follow a process by agreement for developing a disposal facility for solid radioactive waste.	Requirement R1: EA, Geological Disposal Facilities on Land for Solid Radioactive Wastes, Guidance on Requirements for Authorisation [25]
2.18	People, present and future, must be adequately protected against radiation risks.	Fundamental Principle 8: ONR, Safety Assessment Principles for Nuclear Facilities [27]
2.19	Step by step development and evaluation of disposal facilities. Disposal facilities for radioactive waste shall be developed, operated and closed in a series of steps. Each of these steps shall be supported, as necessary, by iterative evaluations of the site, of the options for design, construction, operation and management, and of the performance and safety of the disposal system.	Requirement 11: IAEA, Disposal of Radioactive Waste, Specific Safety Requirements SSR-5 [5]
2.20	The developer should engage in dialogue with the planning authority, potential host community, other interested parties and the general public on its developing environmental safety case.	Requirement R2: EA, Geological Disposal Facilities on Land for Solid Radioactive Wastes, Guidance on Requirements for Authorisation [25]

No.	Requirement	Reference
2.21	In support of the environmental safety case, the developer/ operator of a disposal facility for solid radioactive waste should carry out a programme to monitor for changes caused by construction, operation and closure of the facility.	Requirement R14: EA, Geological Disposal Facilities on Land for Solid Radioactive Wastes, Guidance on Requirements for Authorisation [25] Requirement 21: IAEA, Disposal of Radioactive Waste, Specific Safety Requirements SSR-5 [5]
2.22	Dutyholders must demonstrate effective understanding and control of the hazards posed by a site or facility through a comprehensive and systematic process of safety assessment	Fundamental Principle 4: ONR, Safety Assessment Principles for Nuclear Facilities [27]
2.23	The developer/operator of a disposal facility for solid radioactive waste should establish waste acceptance criteria consistent with the assumptions made in the environmental safety case and with the requirements for transport and handling, and demonstrate that these can be applied during operations at the facility.	Requirement R13: EA, Geological Disposal Facilities on Land for Solid Radioactive Wastes, Guidance on Requirements for Authorisation [25] Requirement 20: IAEA, Disposal of Radioactive Waste, Specific Safety Requirements SSR-5 [5]
2.24	To give confidence that the right decisions will be made for the right reasons, citizens, communities and organisations should have access to information relating to radioactive substances, key decisions should be informed by their views, and the right to justice should be respected.	Fundamental Principle B: EA, Regulatory Guidance Series No RSR 1 Radioactive Substances Regulation – Environmental Principles [26]
2.25	All radioactive substances should be managed within integrated strategies that plan their complete lifecycle taking account of all interactions, dependencies and principles.	Fundamental Principle C: EA, Regulatory Guidance Series No RSR 1 Radioactive Substances Regulation – Environmental Principles [26]
2.26	The best available techniques for the management of radioactive substances should be used. These should be identified from systematic consideration of potential alternatives. Consideration should include human health, safety, the environment, waste prevention, minimisation and disposal and other likely costs and benefits.	Fundamental Principle D: EA, Regulatory Guidance Series No RSR 1 Radioactive Substances Regulation – Environmental Principles [26]

No.	Requirement	Reference
2.27	Decisions on radioactive substances should be informed by best scientific knowledge. Appropriate research should be undertaken to facilitate technology development to promote innovative solutions and where significant gaps in knowledge are recognised.	Fundamental Principle G: EA, Regulatory Guidance Series No RSR 1 Radioactive Substances Regulation – Environmental Principles [26]
2.28	Decisions about radioactive substances should take into account uncertainties and where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing cost effective measures to prevent potential harm to people and the environment.	Fundamental Principle H: EA, Regulatory Guidance Series No RSR 1 Radioactive Substances Regulation – Environmental Principles [26]
2.29	Producers, owners and users of radioactive substances should be accountable for the costs of managing and disposing of their radioactive substances, for associated regulation and research and for rectifying environmental damage.	Fundamental Principle I: EA, Regulatory Guidance Series No RSR 1 Radioactive Substances Regulation – Environmental Principles [26]
2.30	Benefits and detriments arising from practices or interventions involving radioactive substances should be considered to establish whether the practice or intervention is justified.	Fundamental Principle J: EA, Regulatory Guidance Series No RSR 1 Radioactive Substances Regulation – Environmental Principles [26]
2.31	Wastes should be conditioned to yield products that are passively safe, transportable and ultimately disposable.	Joint guidance from the Office of Nuclear Regulation, the Environment Agency, the Scottish Environment Protection Agency and Natural Resources Wales to nuclear licensees [30]

3.4 Safety requirements

3.4.1 Construction safety

Although a geological disposal facility is not subject to the same health and safety legislation that applies to mines, as good practice, tunnelling and underground excavation shall be undertaken after consideration of The Mines Regulations 2014 and associated guidance published by the Health and Safety Executive (HSE).

Safety during construction will be provided by adopting relevant good practice, by working to a well-defined safety management system, and by establishing a strong safety culture.

Where novel technology is used it will be supported by trials. Safety management systems should be based on good practice from the mining and tunnelling industry.

In addition, to comply with legislation, applicable safety standards should be met, in particular, safety management systems should be based on the principles of the British Standard 18001 Occupational Health and Safety Assessment Specification (OHSAS) [45] or the HSE guide to 'Successful health and safety management' [46]. Table 3 sets out the requirements relating to construction safety.

Table 3 Construction safety

No.	Requirement	Reference
3.1	Construction of the disposal facility. The disposal facility shall be constructed in accordance with the design as described in the approved safety case and supporting safety assessment. It shall be constructed in such a way as to preserve the safety functions of the host environment that have been shown in the safety case to be important for safety after closure. Construction activities shall be carried out in such a way as to ensure safety during the operational period.	Requirement 17: IAEA, Disposal of Radioactive Waste, Specific Safety Requirements SSR-5 [5] Client duties: The Construction (Design and Management) Regulations 2015 [36]
3.2	The developer/ operator of a disposal facility for solid radioactive waste should make sure that the site is used and the facility is designed, constructed, operated and capable of closure so as to avoid unacceptable effects on disposal system performance.	Requirement R12: EA, Geological Disposal Facilities on Land for Solid Radioactive Wastes, Guidance on Requirements for Authorisation [25]

3.4.2 Transport safety

As explained in Section 1.4, the responsibility for safe transport does not lie solely with RWM. RWM has responsibilities as the consignee and the waste producers are the consignors. At this stage, the responsible organisation who will act as the carrier is not defined and therefore RWM currently represent the carrier's interest by capturing the related transport requirements.

Table 4 sets out the requirements relating to transport safety. Compliance with the IAEA Regulations covers 'routine' (incident free) 'normal' (minor mishaps) and 'accident' conditions of transport for all types of package and shipment regardless of mode. The requirement to comply with these regulations is implemented in Great Britain through the Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009 (CDG Regulations 2009) [47] and in Northern Ireland through the Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations (Northern Ireland) 2010 [48]. These regulations refer to Annexes A and B of the European Agreement concerning the International Carriage of Dangerous Goods by Road ('ADR') [49], the Regulations (RID) concerning the International Carriage of Dangerous Goods by Rail, appearing as Appendix C to the Convention concerning International Carriage by Rail (COTIF) [50], and the Regulations annexed to the European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways ('ADN') [51]. ADR, RID and ADN establish standards of safety which are based on SSR-6 and the CDG Regulations 2009 require carriage to be in accordance with these European Agreements.

ADN is not fully transposed as the inland waterways of Great Britain do not connect directly with any other Member States.

Table 4 Transport safety

No.	Requirement	Reference
4.1	The transport system for radioactive material shall establish standards of safety which provide an acceptable level of control of the radiation, criticality and thermal hazards to persons, property and the environment that are associated with the transport of radioactive materials.	Paragraph 101: IAEA, Regulations for the Safe Transport of Radioactive Waste, Specific Safety Requirements SSR-6 [24]
4.2	A radiation protection programme shall be established for the transport of radioactive material.	Paragraph 302: IAEA, Regulations for the Safe Transport of Radioactive Waste, Specific Safety Requirements SSR-6 [24]
4.3	The transport system for radioactive materials shall include all reasonably practicable emergency provisions to protect persons, property and the environment in the event of accidents or incidents during transport of radioactive materials.	Paragraph 304: IAEA, Regulations for the Safe Transport of Radioactive Waste, Specific Safety Requirements SSR-6 [24]
4.4	Doses to persons shall be below the relevant dose limits specified in the appropriate regulations.	Paragraph 301 IAEA, Regulations for the Safe Transport of Radioactive Waste, Specific Safety Requirements SSR-6 [24]
4.5	Protection and safety shall be optimised such that the magnitude of individual doses, the number of persons exposed and the likelihood of incurring exposure is as low as reasonably practicable, economic and societal factors being taken into account, within the restriction that the doses to individuals are subject to dose constraints. A structured and systematic approach shall be adopted and shall include considerations of the interfaces between transport and other activities.	Paragraph 301 IAEA, Regulations for the Safe Transport of Radioactive Waste, Specific Safety Requirements SSR-6 [24]
4.6	Transport of radioactive material shall use transport package designs that comply with the requirements and test procedures specified in the IAEA Transport Regulations.	Paragraph 501 IAEA, Regulations for the Safe Transport of Radioactive Waste, Specific Safety Requirements SSR-6 [24]
4.7	The manufacturer, consignor or user of waste packages shall be prepared to (a) provide facilities for inspection during manufacture and use and (b) to demonstrate compliance with these Regulations to the competent authority.	Paragraph 306: IAEA, Regulations for the Safe Transport of Radioactive Waste, Specific Safety Requirements SSR-6 [24]

3.4.3 Operational safety

Safety during operations will be provided by following the general principles of good engineering and operational safety, adopting good practice developed in other areas of underground operation, working to a well-defined safety management system and establishing a strong safety culture.

The ONR SAPs represent guidance to ONR inspectors and provide principles of good practice regarding the design and safety justification of new nuclear facilities, and requirements for compliance with the conditions of nuclear site licences, particularly those relating to the production of nuclear safety cases. Demonstrating good practice in engineering, operation and safety management is a fundamental requirement for safety cases. The establishment of a strong safety culture will ensure that protection and safety issues receive the attention warranted by their significance.

Design Principles [52] and radiological protection criteria [53] have been developed taking into account the IAEA guidance on the Disposal of Radioactive Waste [5]. Although a geological disposal facility will pose a significantly lower operational safety risk than a nuclear power plant, it is considered that (with suitable interpretation) many of the principles are applicable to designing a geological disposal facility to ensure nuclear safety during operation. Table 5 sets out the requirements for operational safety.

Table 5 Operational safety

No.	Requirement	Reference
5.1	Protection must be optimised to provide the highest level of safety that is reasonably practicable.	Fundamental Principle 3: ONR, Safety Assessment Principles for Nuclear Facilities [27] Requirement 4: IAEA, Disposal of Radioactive Waste, Specific Safety Requirements SSR-5 [5] Requirement 16: IAEA, Disposal of Radioactive Waste, Specific Safety Requirements SSR-5 [5] Fundamental Principle E: EA, Regulatory Guidance Series No RSR 1 Radioactive Substances Regulation – Environmental Principles [26]
5.2	Measures for controlling radiation risks must ensure that no individual bears an unacceptable risk of harm.	Fundamental Principle 5: ONR, Safety Assessment Principles for Nuclear Facilities [27]
5.3	All reasonably practicable steps must be taken to prevent and mitigate nuclear or radiation accidents.	Fundamental Principle 6: ONR, Safety Assessment Principles for Nuclear Facilities [27]
5.4	Arrangements must be made for emergency preparedness and response in case of nuclear or radiation incidents.	Fundamental Principle 7: ONR, Safety Assessment Principles for Nuclear Facilities [27]
5.5	The developer/operator of a disposal facility for solid radioactive waste should make sure that the site is used and the facility is designed, constructed and operated and capable of closure so as to avoid unacceptable effects on the performance of the disposal system. (GRA) The disposal facility shall be operated in accordance with the conditions of the licence and the relevant regulatory requirements so as to maintain safety during the operational period and in such a manner as to preserve the safety functions assumed in the safety case that are important to safety after closure. (SSR-5)	Requirement R12: EA, Geological Disposal Facilities on Land for Solid Radioactive Wastes, Guidance on Requirements for Authorisation [25] Requirement 18: IAEA, Disposal of Radioactive Waste, Specific Safety Requirements SSR-5 [5] Requirement 19: IAEA, Disposal of Radioactive Waste, Specific Safety Requirements SSR-5 [5]

No.	Requirement	Reference
5.6	During the period of authorisation of a disposal facility for solid radioactive waste, the effective dose from the facility to a representative member of the critical group should not exceed a source-related dose and a site- related dose constraint: -0.3 mSv per year from any source from which radioactive discharges are made; or - 0.5 mSv per year from the discharges from any single site.	Requirement R5: EA, Geological Disposal Facilities on Land for Solid Radioactive Wastes, Guidance on Requirements for Authorisation [25]

3.4.4 Post-closure safety

Post closure safety is achieved through the development of a disposal system in which the various components including the host geological environment work together through mutually complementary interactions. This approach allows flexibility to the RWM engineers to design a GDF in a way that takes advantage of the natural characteristics of the site and the barrier potential of the host geological environment. Table 6 sets out the requirements relating to post closure safety.

Table 6 Post-closure safety

No.	Requirement	Reference
6.1	The disposal facility shall be sited, designed and operated to provide features that are aimed at isolation of the radioactive waste from people and from the accessible biosphere. The features shall aim to provide isolation for several hundreds of years for short lived waste and at least several thousand years for intermediate and high level waste. In so doing, consideration shall be given to both the natural evolution of the disposal system and events causing disturbance of the facility.	Requirement 9: IAEA, Disposal of Radioactive Waste, Specific Safety Requirements SSR-5 [5]
6.2	The engineered barriers, including the wasteform and packaging, shall be designed, and the host environment shall be selected, so as to provide containment of the radionuclides associated with the waste. Containment shall be provided until radioactive decay has significantly reduced the hazard posed by the waste. In addition, in the case of heat generating waste, containment shall be provided while the waste is still producing heat energy in amounts that could adversely affect the performance of the disposal system.	Requirement 8: IAEA, Disposal of Radioactive Waste, Specific Safety Requirements SSR-5 [5]
6.3	The developer/operator of a geological disposal facility should assume that human intrusion after the period of authorisation is highly unlikely to occur. The developer/operator should consider and implement any practical measures that might reduce this likelihood still further. The developer/operator should also assess the potential consequences of human intrusion after the period of authorisation.	Requirement R7: EA, Geological Disposal Facilities on Land for Solid Radioactive Wastes, Guidance on Requirements for Authorisation [25]
6.4	An appropriate level of surveillance and control shall be applied to protect and preserve the passive safety features, to the extent that this is necessary, so that they can fulfil the functions that they are assigned in the safety case for safety after closure.	Requirement 10: IAEA, Disposal of Radioactive Waste, Specific Safety Requirements SSR-5 [5]
6.5	After the period of authorisation, the assessed radiological risk from a disposal facility to a person representative of those at greatest risk should be consistent with a risk guidance level of 10^{-6} per year (i.e. 1 in a million per year).	Requirement R6: EA, Geological Disposal Facilities on Land for Solid Radioactive Wastes, Guidance on Requirements for Authorisation [25]

No.	Requirement	Reference
6.6	The developer/operator of a disposal facility for solid radioactive waste should demonstrate that the disposal system provides adequate protection against non-radiological hazards.	Requirement R10: EA, Geological Disposal Facilities on Land for Solid Radioactive Wastes, Guidance on Requirements for Authorisation [25]
6.7	Multiple safety functions. The host environment shall be selected, the engineered barriers of the disposal facility shall be designed and the facility shall be operated to ensure that safety is provided by means of multiple safety functions. Containment and isolation of the waste shall be provided by means of a number of physical barriers of the disposal system. The performance of these physical barriers shall be achieved by means of diverse physical and chemical processes together with various operational controls. The capability of the individual barriers and controls together with that of the overall disposal system to perform as assumed in the safety case shall be demonstrated. The overall performance of the disposal system shall not be unduly dependent on a single safety function.	Requirement 7: IAEA, Disposal of Radioactive Waste, Specific Safety Requirements SSR-5 [5]
6.8	The disposal facility and its engineered barriers shall be designed to contain the waste with its associated hazard, to be physically and chemically compatible with the host geological formation and/or surface environment, and to provide safety features after closure that complement those features afforded by the host environment. The facility and its engineered barriers shall be designed to provide safety during the operational period.	Requirement 16: IAEA, Disposal of Radioactive Waste, Specific Safety Requirements SSR-5 [5]

3.5 Environmental requirements

To comply with legislative requirements and national guidance relating to the development consent process, proposals for the design, construction, operation and closure of a geological disposal facility at a specific site must be subject to Environmental Impact Assessment (EIA) [42] and Habitats Regulations Assessment (HRA) [41].

An EIA must include consideration of potential effects relating, but not necessarily limited to the following:

- population and human health
- biodiversity
- land
- soil
- water
- air
- climate (for example greenhouse gas emissions, effects relevant to adaptation)

- material assets
- cultural heritage
- landscape and
- disaster risk

The Habitats Regulations require *'competent authorities'* to be satisfied that the integrity of designated *'European Sites'* and their conservation objectives will not be adversely affected by a proposed plan or project, before development consent is granted. If significant effects are judged likely, then alternative solutions must be considered. If no satisfactory alternatives can be found, or effective mitigation measures applied, then the proposal may only go ahead on the basis of *'imperative reasons of overriding public interest'*. Table 7 sets out the environmental requirements on the disposal system.

Table 7 Environmental requirements

No.	Requirement	Reference
7.1	Radioactive substances should be managed to avoid placing a burden on future generations and their environment such that it compromises their ability to meet their needs.	Fundamental Principle A: EA, Regulatory Guidance Series No RSR 1 Radioactive Substances Regulation – Environmental Principles [26]
7.2	Undertake EIA of GDF implementation, including sustainability and Habitats Regulations assessment and review as necessary to reflect significant changes on the site or elsewhere that might affect knowledge or understanding of EIA[8].	EU Council Directive 2014/52/EU of 16 April 2014 amending Directive 2011/52/EU on the assessment of the effects of certain public and private projects on the environment [42] The Stationary Office, Conservation of Habitats and Species Regulations 2010 [41] NDA, Client Specification, RWM, ref 1.3i [55]
7.3	The choice of waste acceptance criteria, how the selected site is used and the design, construction, operation, closure and post-closure management of the disposal facility should ensure that the radiological risks to members of the public, both during the period of authorisation and afterwards, are as low as reasonably achievable (ALARA), taking into account economic and societal factors.	Requirement R8: EA, Geological Disposal Facilities on Land for Solid Radioactive Wastes, Guidance on Requirements for Authorisation [25]

[8] Socioeconomic aspects of EIA are addressed in Section 4.4.

3.6 Security requirements

Physical protection and security measures are required for the safety of the public and staff, protection of plant and equipment, and the safeguarding of nuclear materials. The Nuclear Industry Security Regulations 2003 require certain premises on which nuclear material and/or other radioactive material are present to have a nuclear site security plan that describes in writing the standards, procedures and arrangements adopted or to be adopted by the operator to ensure the security of the premises. This includes the nuclear material and/or other radioactive material, any equipment or software associated with its management and any sensitive nuclear information.

RWM will consult with ONR during the design of the disposal system, and any undertaking to design a Category I or Category II facility will necessitate the allocation of an ONR Inspector to oversee and approve the security measures. Table 8 sets out GDF security requirements.

Table 8 Security requirements

No.	Requirement	Reference
8.1	The disposal system shall be designed to provide physical protection and integrated security measures to prevent misuse of fissile or radioactive materials.	The Stationary Office, Nuclear Industry Security Regulations, 2003 [28]
8.2	Measures shall be implemented to ensure an integrated approach to safety measures and nuclear security measures in the disposal of radioactive waste.	Requirement 24: IAEA, Disposal of Radioactive Waste, Specific Safety Requirements SSR-5 [5]

3.7 Safeguards requirements

Euratom Regulation 302/2005 [40] includes an explicit reference to the application of safeguards to 'waste'. The Regulation defines *'waste'* as:

> *"…nuclear material in concentrations or chemical forms considered as irrecoverable for practical or economic reasons and which may be disposed of."*

Geological disposal facility systems, procedures and records will be designed and implemented in a way that gives assurance to inspectors of the IAEA and European Commission (Directorate-General: Energy) that nuclear material arising from civilian nuclear processes is not diverted for military use or other undeclared purposes.

Some of the wastes destined for the UK geological disposal facility will contain nuclear materials. However, most wastes are unlikely to constitute a significant proliferation threat. In consultation with the Government and the developer/operator, the safeguards authorities will develop an approach to meeting safeguards requirements based on disposal system design, operational constraints and nuclear materials type, quantity and form. The safeguards approach will therefore be commensurate with the perceived proliferation risk at each stage of the waste lifecycle.

Important considerations when developing the safeguards strategy include the ability to verify the nuclear material content and to maintain a continuity of knowledge following these verification measurements, up to the point of committal for emplacement (prior to backfilling), irrespective of the point in the process at which this verification is performed.

The safeguards approach at a geological disposal facility will be overseen by the UK Safeguards Office. Wastes containing isotopes of uranium, plutonium or thorium derived from the UK civil nuclear programme are likely to be subject to international safeguards and

as such, reported to the UK Safeguards Office. Table 9 sets out GDF safeguards requirements.

Table 9 Safeguards requirements

No.	Requirement	Reference
9.1	The disposal system shall be developed to give assurance to the competent authority that civil nuclear materials are not diverted for military use or other undeclared purposes.	Commission Regulation (Euratom) No 302/2005 of March 2005 [40]
9.2	In the design and operation of disposal facilities subject to agreements on accounting for, and control of, nuclear material, consideration shall be given to ensuring that safety is not compromised by the measures required under the system of accounting for, and control of, nuclear material.	Requirement 23: IAEA, Disposal of Radioactive Waste, Specific Safety Requirements SSR-5 [5]

4 Stakeholder Requirements

For the purpose of this document, RWM has adopted the Nuclear Energy Agency's (NEA) definition of a *'stakeholder'*, that is [54]:

> *"any actor - institution, group or individual - with an interest or a role to play in the radioactive waste management process"*

Dialogue and stakeholder involvement is central to the waste management process as a whole and there are many different stakeholders whose involvement may depend on the stage of the GDF siting and implementation process. Examples of stakeholders may be (but are not limited to); Non-Governmental Organisations, representatives of local communities, trade unions, or waste producers.

As stated in the 2014 White Paper [2] the Government intends to develop the detail of a process for working with communities and to address the issues related to community representation and engagement at potential GDF sites. RWM expect further stakeholder requirements to be defined in the site-specific stage as the programme progresses; therefore this section sets out RWM's current understanding of stakeholder requirements at the generic stage.

4.1 General

Table 10 sets out RWM's current understanding of general stakeholder requirements.

Table 10 General stakeholder requirements

No.	Requirement	Reference
10.1	The closure of a GDF and the Site End State for surface facilities shall comply with all applicable regulatory requirements.	NDA, Client Specification, RWM, ref 1.1b [55]
10.2	With due regard to principles of waste hierarchy and where practicable, make optimal use of a GDF for the disposal of GDF decommissioning wastes.	NDA, Client Specification, RWM, ref 1.1c, 4.7b [55]
10.3	Avoid the creation of new radioactive or non-radioactive contaminated land.	NDA, Client Specification, RWM, ref 1.2c [55]
10.4	Manage radioactive and non-radioactive contamination, in, on, or under the designated site and any contamination emanating from the designated site for which the NDA or RWM is deemed responsible under relevant statutory provisions.	NDA, Client Specification, RWM, ref 1.2e [55]
10.5	Develop a programme for determining the most suitable Site End State reflecting post closure plans (taking into account the NDA value framework).	NDA, Client Specification, RWM, ref 1.3a [55]
10.6	Work with regulators and key stakeholders (including the host community) to define assumptions for Site End State principles and appropriate institutional controls for the phases of a GDF lifecycle.	NDA, Client Specification, RWM, ref 1.3c [55]

No.	Requirement	Reference
10.7	Demonstrate that safety and environmental regulatory requirements and planning obligations can be achieved and relevant requirements of international guidance.	NDA, Client Specification, RWM, ref 1.3d [55]
10.8	Develop and implement a single facility providing that this is technically achievable and a safety and environmental case can be made for such a facility.	NDA, Client Specification, RWM, ref 1.3f [55]
10.9	Engage with regulators during development, operation and closure of a GDF to ensure compliance with regulatory requirements including those relevant to post-closure.	NDA, Client Specification, RWM, ref 1.3k [55]
10.10	Subject to confirmation of disposability, accept risk and title to waste consigned to the GDF.	NDA, Client Specification, RWM, ref 2.2k [55]
10.11	We are currently proceeding on the assumption that only one GDF will be necessary (subject to the safety case meeting the requirements of the independent regulators).	2014 White Paper Para 2.19 [2] NDA, Client Specification, RWM, ref assumption A4(c) [55]
10.12	Establish the ownership of the land and mineral rights at any GDF site and in the region around the site. Ensure that appropriate access and control arrangements can be put in place and implement such arrangements for any selected site.	NDA Client Specification, RWM, ref 5.1b [55]
10.13	In developing transport plans, safety, security, cost, environmental impact, disturbance throughout the transport route, value for money and effective utilisation of existing NDA owned assets and resources shall be considered.	NDA Client Specification 6.10a [55]
10.14	Ensure that the suitability of existing infrastructure, particularly the use of NDA assets is considered before investing in new infrastructure for a GDF.	NDA Client Specification 6.10f [55]

4.2 Cost effectiveness

A GDF will be a major infrastructure project and a significant long term investment for the UK. The precise costs of the GDF will depend on a number of factors including the type of rock within which it is constructed and the length of the operational period. As the developer of the GDF, RWM is responsible for safety, security and environmental protection whilst also delivering a cost effective disposal facility throughout the lifetime of the programme. Table 11 sets out requirements related to cost effective GDF delivery.

Table 11 Cost effectiveness

No.	Requirement	Reference
11.1	The developer shall be responsible for cost effective delivery throughout the lifetime of the programme.	2014 White Paper Para 7.22 [2]
11.2	Ensure that the Disposal System Safety Case (DSSC) develops in a manner that supports and enables safe and cost effective disposal of the inventory for disposal, as described in the 2014 White Paper and detailed in the RWM Derived Inventory.	NDA, Client Specification, RWM, ref 1.3g [55]

4.3 Schedule

Operation of the GDF is bounded by receipt of waste, plus any radioactive materials that may become classified as waste in the future (see Table 1). Indicative timescales are developed through dialogue with waste producers. Table 12 sets out requirements relating to the schedule of waste receipt.

Table 12 Schedule of waste receipt

No.	Requirement	Reference
12.1	Accept waste in line with the GDF schedule.	NDA Client Specification ref 2.2j. [55]
12.2	The operating timescales for the disposal system are currently assumed to be: • 2040 for ILW/LLW • 2075 for HLW/SF • the disposal of DNLEU could potentially commence at the same time as UILW provided this does not exceed the capacity of the inlet cell. • the disposal of plutonium and high-enriched uranium commences following completion of legacy HLW and SF • NNB ILW would be disposed of in parallel with DNLEU • disposal of MOX SF commencing in 2131 • disposal of NNB SF commencing in 2145	Assumptions developed through dialogue with waste owners.

4.4 Socioeconomic factors

To comply with legislative requirements and national guidance relating to the development consent process, proposals for the design, construction, operation and closure of a GDF at a specific site are subject to Environmental Impact Assessment (EIA) [56]. It is a requirement under the EIA Directive to consider *'reasonable alternatives'*. The disposal system will be developed with consideration of alternative concept designs for

implementing geological disposal and alternative options for the transport of radioactive waste to a geological disposal facility [57].

The assessment of socio-economic effects, while not an explicit legislative requirement, will be included within the scope of generic and community-specific assessments, and within the scope of EIA. Socioeconomic assessment will include consideration of the following issues:

- employment
- property values
- economic development
- tourism
- the agricultural economy
- social services and infrastructure
- social stability and community cohesion and
- housing and accommodation

Table 13 sets out requirements relating to the socio economic factors.

Table 13 Socioeconomic factors

No.	Requirement	Reference
13.1	Undertake EIA of GDF implementation and develop the disposal system with due regard to its socio-economic implications[9].	EU Council Directive 2014/92/EU of 16 April 2014 amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment. [42]
13.2	Work in partnership with potential host communities to implement a GDF in a way that enhances the socio-economic wellbeing of the community.	NDA Client Specification RWM ref 5.2a [55]

4.5 Retrievability

The Government, the Committee on Radioactive Waste Management (CoRWM) and the regulators agree that the purpose of a GDF is to dispose of waste, not to store it. The 2014 White Paper notes that permanently closing a GDF at the earliest opportunity once operations have ceased provides for greater safety, greater security, and minimises the burden on future generations [2].

During the operation phase of the GDF, waste that has been emplaced could be retrieved. Retrieval of waste would become increasingly more difficult with time particularly after cessation of the operation phase and closure and sealing of the GDF. Requirements related to retrievability are set out in Table 14.

[9] Environmental aspects of EIA are addressed in Section 3.4.4.

Table 14 Retrievability

No.	Requirement	Reference
14.1	Planning, design and construction of a GDF shall be such that a GDF can be closed, and institutional control withdrawn, without violating safety requirements however; this does not preclude the option of retrievability prior to closure.	Based on 2014 White Paper Para 3.22 [2]

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Glossary

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

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