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Joint regulatory scrutiny of RWMD's work relating to geological disposal of higher activity radioactive waste: Regulatory review of the generic disposal system safety case

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Executive summary

The Nuclear Decommissioning Authority's (NDA's) Radioactive Waste Management Directorate (RWMD) is developing concepts for geological disposal of the UK's higher activity radioactive waste (HAW). The Office for Nuclear Regulation (ONR) and the Environment Agency (collectively termed 'the Regulators' in this review) have established agreements with RWMD to review RWMD's early work towards implementing geological disposal and developing a geological disposal facility (GDF)[i]. This scrutiny will help RWMD to progress implementation and to develop the applications necessary for licensing and permitting purposes.

In February 2011 RWMD published a suite of safety case reports for a future GDF. The safety case is based on RWMD's understanding of the scientific and engineering principles supporting geological disposal. A specific site for a GDF has not yet been identified. The safety case is based on assumptions regarding possible geological settings and facility designs, and is referred to as the 2010 *generic* Disposal System Safety Case (gDSSC).

We have reviewed the gDSSC under the terms of our agreements with, and at the request of, RWMD. Our regulatory review brings together the views of transport safety and nuclear safety specialists from the Office for Nuclear Regulation (ONR) and radioactive waste disposal specialists from the Environment Agency. Our review provides advice and comment to RWMD on matters within our respective regulatory remits; it does not form the basis of any regulatory decision. The main body of the report provides general and overview comments. The three annexes provide comments on transport safety (Annex 1), operational safety including construction safety (Annex 2) and environmental safety (Annex 3).

We consider that the broad structure of the gDSSC is acceptable in terms of the general coverage of the documents and of the links shown between them, and that the documentation is of generally high quality. The gDSSC provides confidence, to a degree appropriate at this early stage in implementing geological disposal, that a safety case for a GDF in the UK could be made, providing a suitable site is available. Our position is, however, subject to some reservations that we present in this review.

From our review of the gDSSC, we have identified no specific issues that would prevent a safety case, capable of meeting transport, operational and environmental regulatory requirements, being made for a GDF in the future, providing a suitable site is available and RWMD continues to work with us to address our issues and concerns.

[i] During the course of this review the Nuclear Directorate of the Health and Safety Executive became the Office for Nuclear Regulation (ONR) and was joined by relevant parts of the Department for Transport (DfT) that regulate the transport of radioactive materials.

Contents

1 Introduction

1.1 The UK Government has designated the Nuclear Decommissioning Authority (NDA) as the implementing organisation for geological disposal of the UK's higher activity radioactive waste (HAW). The NDA has established a Radioactive Waste Management Directorate (RWMD) to become the delivery organisation for geological disposal. The Office for Nuclear Regulation (ONR) and the Environment Agency, (collectively termed 'the Regulators' in this review) have established agreements with RWMD to review RWMD's work towards implementing geological disposal and developing a geological disposal facility (GDF). This scrutiny will help RWMD to progress implementation and to develop the applications necessary for licensing and permitting purposes.

1.2 It is not possible to produce a safety case for a specific GDF unless and until a site has been selected and adequately characterised, and a site-specific facility design produced. In February 2011 RWMD published a suite of safety case reports for a future GDF, based on its understanding of the scientific and engineering principles supporting geological disposal. A specific site for a GDF has not yet been identified. The safety case is based on assumptions about possible geological settings and facility designs, and is referred to as the 2010 *generic* Disposal System Safety Case (gDSSC).

This review provides advice and comment to RWMD on matters within our respective regulatory remits; it does not form the basis of any regulatory decision.

1.3 We have reviewed the gDSSC under the terms of our agreements with, and at the request of, RWMD. Our regulatory review brings together the views of specialists in transport and nuclear safety from the Office for Nuclear Regulation (ONR) and specialists in radioactive waste disposal from the Environment Agency. Our review provides advice and comment to RWMD on matters within our respective regulatory remits; it does not form the basis of any regulatory decision. The main body of the report provides general and overview comments. The three annexes provide comments on transport safety (Annex 1), operational safety including construction safety (Annex 2) and environmental safety (Annex 3).

2 Context

2.1 RWMD asked us to review the 2010 gDSSC to:

- **Identify whether there are any fundamental issues that would prevent a future safety case for a GDF being made;**
- **Provide advice and guidance to RWMD on how it can develop the future geological disposal system safety case; and**
- **identify specific areas where work is required.**

2.2 Feedback from the Regulators is important: it will help RWMD develop a safety case for a GDF and provide information to support the UK Government's process for implementing geological disposal (Managing Radioactive Waste Safely (MRWS) [1]) . In addition, the gDSSC will provide much of the basis for assessments of radioactive waste packaging proposals under RWMD's Letter of Compliance (LoC) process, which we use to help inform our assessments of licensees' arrangements for managing radioactive waste. We need to be satisfied that waste packaging proposals are soundly based.

2.3 RWMD has told us that: (i) it foresees the gDSSC as having a continuing existence at least until the time that RWMD submits a Preliminary Environmental Safety Evaluation (PESE) of a chosen site during the initial part of MRWS Stage 6; (ii) until then, it will use the gDSSC as a basis for the LoC disposability assessment process and to help judge the suitability of a potential site or sites; and (iii) it intends to update the gDSSC on a rolling basis, by updating individual documents of the gDSSC suite when appropriate.

2.4 The gDSSC will thus continue to have a role for some time after we start formally to regulate any disposal project managed by RWMD, when RWMD will be making decisions that may be of interest to us based wholly or partly on the gDSSC.

We provide advice to RWMD through early dialogue prior to formal regulation. Our comments from this review are intended to help RWMD improve the quality of any future regulatory submissions.

2.5 The 2010 gDSSC, published in February 2011, represents a snapshot in time of an evolving suite of documents with a continuing purpose over a significant number of years. We are committed to giving advice to RWMD through early dialogue prior to formal regulation. Our comments from this review give RWMD our early views on regulatory matters. Our aim is to help RWMD improve the quality (i.e. fitness for the specified purpose) of updates to the 2010 gDSSC and any future regulatory submissions.

2.6 RWMD will need to make the transition from a generic safety case based on generic work to the intended future position of a site-specific safety case based substantially on site-specific work. The process of making this transition will be intricate and probably cannot be fully mapped out in advance. We will continue to engage with RWMD to help ensure that this transition is successfully managed in an appropriate and transparent manner.

3 Purpose of Regulators' Review

3.1 The overall purpose of the Regulators' review of the gDSSC has been to:

- **Identify whether there are any fundamental issues that would prevent a future safety case for any GDF being made;**

- **Make recommendations for RWMD to consider when developing any future safety case and identify any specific areas where the case presented needs to be strengthened;**

- **Assist us in providing information and advice to the Government, any stakeholders or communities, including the West Cumbria MRWS Partnership, and the planning authorities in support of the MRWS process;**

- **Determine whether the 2010 gDSSC achieves the appropriate regulatory expectations set out in HSE's *Safety Assessment Principles* (SAPs) [2] (noting that these do not specifically consider the requirements for disposal facilities) and the environment agencies' *Geological Disposal Facilities on Land for Solid Radioactive Wastes: Guidance on Requirements for Authorisation* (GRA) [3].**

4 Scope of Regulators' Review

4.1 Our review includes all the documents that RWMD submitted for consideration by the Regulators as 'the gDSSC' (Table 1). Specialists in transport and nuclear safety within the Office for Nuclear Regulation (ONR) and radioactive waste disposal specialists within the Environment Agency have each focused on documents within their own field of expertise, but have taken into account the wider context (from other documents) where appropriate. In addition, we have considered the R&D Programme Overview document [4], which lies outside the gDSSC suite of documents but was issued at about the same time as the 2010 gDSSC. We have included that document because it strongly relates to the research status reports within the gDSSC suite and identifies where RWMD might be planning research. This allows us to check whether work, that from our review we think is necessary, is adequately covered in RWMD's forward R&D programme.

4.2 In general, our review has excluded related information that has not been published as part of the gDSSC, for example: the site/geosphere characterisation strategy; and waste acceptance criteria development strategy. We decided that to review such additional documents systematically would make our review task unmanageable. We will address these documents and any work arising from them through our ongoing scrutiny programme. In some instances, however, we had to look at documents outside the gDSSC suite so as to understand fully and to confirm the statements made in the 2010 gDSSC.

4.3 Except where otherwise indicated, our comments are based on what we see written in (or what we interpret from) the gDSSC suite of documents, and not on what we have read elsewhere or on what else we might have been told.

4.4 We shall separately review the R&D underpinning the gDSSC and the ways in which RWMD intends to identify and fill any gaps in the knowledge base for the gDSSC through our ongoing scrutiny programme.

Table 1: Documents included in Regulators' review of the 2011 generic DSSC

Inventory
Geological Disposal: Radioactive wastes and assessment of the disposability of waste packages (NDA/RWMD/039 – extension of the previous "Nature & Quantities" report)
An Introduction to the Derived Inventory
Development of the Derived Inventory for ILW & LLW based on the 2007 UK Radioactive Waste Inventory (Pöyry Energy Ltd contract report 390685/12)
Development of the Derived Inventory for HLW and Spent Fuel based on the 2007 UK Radioactive Waste Inventory (Pöyry Energy Ltd contract report 390710/11)
Production of the Derived Inventory for new build reactor wastes (Pöyry Energy Ltd contract report 390727/8)
Production of the Derived Inventory for uranium and plutonium (Pöyry Energy Ltd contract report 390727/7)
Specifications and Design
Geological Disposal: Generic Disposal System Functional Specification (NDA/RWMD/043)
Disposal System Technical Specification (NDA/RWMD/044)
Summary of Generic Designs (NDA/RWMD/054)
Generic Transport System Designs (NDA/RWMD/046)
Generic Disposal Facility Designs (NDA/RWMD/048)
Safety and Environmental Assessment
An Overview of the Disposal System Safety Case (NDA/RWMD/010)
Generic Transport Safety Case Main Report (NDA/RWMD/019)
Generic Operational Safety Case Main Report (NDA/RWMD/020)
Generic Environmental Safety Case: Main Report (NDA/RWMD/021)
Transport System Safety Assessment (NDA/RWMD/022)
Transport Package Safety Report (NDA/RWMD/023)
Safety Case Production and Management (NDA/RWMD/024)
Operations Safety Assessment: 1 Construction and Conventional Safety Assessment (NDA/RWMD/025)
Operations Safety Assessment: 2 Normal Operations Operator Dose Assessment (NDA/RWMD/026)
Operations Safety Assessment: 3 Accident Safety Assessment (RESTRICTED) (NDA/RWMD/027)
Operations Safety Assessment: 4 Criticality Safety Assessment (RESTRICTED) (NDA/RWMD/028)
Operational Environmental Safety Assessment (NDA/RWMD/029)
Post-closure Safety Assessment (NDA/RWMD/030)
Research Status Reports
Package Evolution Status Report (NDA/RWMD/031)
Waste Package Accident Performance Status Report (NDA/RWMD/032)
Near Field Evolution Status Report (NDA/RWMD/033)
Radionuclide Behaviour Status Report (NDA/RWMD/034)
Geosphere Status Report (NDA/RWMD/035)
Biosphere Status Report (NDA/RWMD/036)
Gas Status Report (NDA/RWMD/037)
Criticality Safety Status Report (NDA/RWMD/038)
Other Report included in scope of review
R&D Programme overview: Research and development needs in the preparatory studies phase (NDA/RWMD/073)

5 Overview & general comments

5.1 Our main positive points

5.1.1 We **recognise and commend** the steps RWMD has taken in publishing the 2010 gDSSC, thus making it amenable to wide external scrutiny.

Content

5.1.2 We recognise that RWMD has made a very substantial commitment of resources to reach this stage with the gDSSC, especially whilst maintaining it as a generic suite of live documents. We agree with RWMD's peer reviewers [5] that the generic "*DSSC has collated and integrated a considerable body of information*..." and that "*this collation and integration of information is an important and not insubstantial achievement.*" Much of the content of the gDSSC is not new but a demonstration of awareness of existing knowledge.

5.1.3 We are broadly satisfied with the claims, arguments and evidence set out in the gDSSC, subject to the reservations and comments made in this review. The gDSSC draws together the accumulated knowledge and experience, acquired over many years by RWMD, to demonstrate that a safety case, covering transport, operational and environmental issues, could be made for a GDF in the UK. It provides a baseline for RWMD to progress its work on implementing geological disposal.

Structure

5.1.4 We consider that the broad structure of the gDSSC is acceptable in terms of the general coverage of the documents and of the links shown between them, as portrayed, for example, in the Appendix of the 'Tier 0' document *An overview of the generic Disposal System Safety Case* [6]. The documentation is of generally high quality and provides an appropriate level of confidence at this early stage in implementing geological disposal. Our position is subject to the reservations set out in this review.

Regulatory Position

We have identified no specific issues that would prevent a safety case, capable of meeting regulatory requirements, being made for a GDF in the future.

5.1.5 We have identified no specific issues, from our review of the gDSSC, that would prevent a safety case, capable of meeting transport, operational and environmental regulatory requirements, being made for a GDF in the future,

providing a suitable site is available and RWMD continues to work with us to address our issues and concerns.

5.2 Our Main Reservations

Content

RWMD should explain the future role of the gDSSC and develop a clear route map to show how it might develop the gDSSC towards a site-specific Disposal System Safety Case (DSSC).

5.2.1 We regard the safety case documentation as central to any GDF project. The gDSSC is an important source of information about the project for many interested parties including RWMD and its contractors, the Regulators, Government, local community groups, and individuals.

5.2.2 The gDSSC in its present form is not successful in terms of looking to the future and establishing strategic principles, objectives and ambitions that will remain relevant for the longer term. It provides a good summary of the position that RWMD has reached so far, but it does not explain the route forward – apart from reproducing material published in the Government's 2008 White Paper, Managing Radioactive Waste Safely (Cm 7386) [1].

5.2.3 A GDF project will involve up to around three decades of site investigation, design and construction, followed by perhaps 100 years of operation. RWMD needs to address the issues that such timescales present by creating a set of strategic principles, objectives and ambitions to which all relevant and interested parties (such as the developer of a GDF, the Regulators, Government, local community groups, and individuals) can refer over the coming decades. A subset of this material will be relevant to a GDF safety case. We would expect the gDSSC to describe how the key components of the safety case, covering transport, operational and environmental issues, will be managed over many decades, recognising the need to deal with intergenerational knowledge transfer.

5.2.4 In the shorter term, the 2010 gDSSC does not explain how RWMD might develop the gDSSC documents towards a site-specific Disposal System Safety Case (DSSC). There are no close UK precedents for such progressive development of a safety case and any overseas precedents are likely to be of limited relevance. This lack of clarity could lead to difficulties in the future. We are aware of the considerable efforts that RWMD continues to take to understand and meet regulatory requirements and to support the

implementation of geological disposal, and from our discussions with RWMD, it is clear that RWMD is continuing to develop its thoughts on this matter[ii].

5.2.5 The way that RWMD describes the LoC disposability assessment process provides an example of the lack of visible forward thinking. The relevant document [7] in the gDSSC suite does not set out the strategy and future programme for developing the LoC disposability assessment process. We are aware that RWMD is currently improving this process.

5.2.6 We feel strongly that there should be continuing engagement between RWMD and the Regulators to enable RWMD to establish and explain the future role of the gDSSC and a clear route map towards any future site-specific DSSC.

Structure

There is much repetition and overlap between documents in the gDSSC. RWMD should aim to strike a better balance that will address the needs of different audiences, and help to produce a stable and enduring suite of safety case documents.

5.2.7 We have said that we find the broad structure of the gDSSC acceptable in terms of the general coverage of the documents and of the links shown between them. However, when we examine the documents in more detail, structural issues emerge. RWMD has told us that it decided to make each of the gDSSC documents self-standing in order to help readers interested only in particular topics. This has led to much repetition and overlap between documents, which does not help those readers who want to understand groups of documents or the gDSSC as a whole. It can be difficult to understand the intended role of each document and the order in which documents should be read. RWMD should aim to strike a better balance that will address the needs of different audiences.

5.2.8 When changes are needed, the repetition and overlap will make it hard to update the gDSSC consistently across the suite of documents. It is difficult to envisage using the gDSSC in its current form as a basis for formal regulation of a GDF project. The volume of project documentation and the detail that the gDSSC would need to capture will increase progressively. Instead, we suggest that RWMD could focus each document on its core scope, making each more concise (in some instances, very concise), easier to read and easier to update. RWMD should consider the structure of the gDSSC carefully so that a stable suite of safety case documents can be produced that may endure through several editions of the documentation, and thereby facilitate regulatory scrutiny over a lengthy period.

[ii] We are aware that during the course of our review RWMD has developed an ESC Strategy and is in the process of producing transport and operational safety strategies.

5.2.9 We think an important part of the solution would be for RWMD to provide a set of overarching topic/strategic documents that are directed towards the judgements that the Regulators will need to make. For example there could be a document that gives a strategic technical overview across the transport, operational and environmental safety case documents: this would facilitate regulatory judgements on matters that extend across the three safety cases.

5.2.10 We provide an illustration of how the topic/strategic approach might be applied to the transport safety case (Annex 1 Figure 1).

gDSSC as a Coherent & Self-Contained Entity

5.2.11 A DSSC needs to be coherent and largely self-contained, but we recognise that it will be supported by, and include references to, a much wider set of documentation. The role of the gDSSC in the context of all the documentation for the geological disposal project needs to be clearly and consistently explained. Where reference is made to a document not included in the gDSSC, the gDSSC should clearly and succinctly explain the relevant matter. It should include enough information to enable the detail to be tracked and checked easily and efficiently (for example, by reference to a specific section or page, and not merely to a whole document). The gDSSC only partly achieves this aim.

Accessibility to a Wide Audience

RWMD should continue to work towards making the gDSSC reasonably accessible to a wide audience. We have made some suggestions as to how this might be achieved.

5.2.12 RWMD will periodically update parts of the gDSSC and it will be a major source of reference over an extended period. We would urge RWMD to continue to work towards making it reasonably accessible to a wide audience. In its present form it only partly succeeds in this. GRA [3] Requirement R2, *Dialogue with potential host communities and others*, is relevant to this point:

"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."

5.2.13 RWMD has produced a top-level document [6], the 'Tier 0' document, aimed at a wide audience. This successfully outlines the broader context of the gDSSC including, for example, the wastes to be disposed of, the concept of geological disposal and the MRWS process. It also describes, in an understandable way, the issues associated with various parts of the safety case.

5.2.14 The 'Tier 0' document does not adequately describe the purpose and content of the gDSSC, nor the purpose and content of the Tier 1 documents (the Generic Transport Safety Case [8], the Generic Operational Safety Case [9] and the Generic Environmental Safety Case [10]). We think that these are significant omissions.

5.2.15 The Tier 1 documents (the Generic Transport Safety Case [8], the Generic Operational Safety Case [9] and the Generic Environmental Safety Case [10]) are long and detailed reports: many people may find them off-putting and difficult to understand. To improve accessibility, we suggest that RWMD could provide a description suitable for a wide audience in each Tier 1 document of the purpose and content of that document. More generally, we suggest that RWMD could consider producing separate non-technical summaries for many of the reports in the gDSSC suite.

5.2.16 Accessibility could also be improved by providing additional overview diagrams. For example, a simple overview diagram that shows the various routes that waste will take within a GDF would aid understanding of the operation of the facility.

Management of Change

RWMD needs to clarify how it will apply change control to the suite of documents and the statements it contains.

5.2.17 In discussions with us, RWMD has proposed to use the 2010 gDSSC as a baseline for the future development of a GDF safety case, subjecting the statements contained in documents in the gDSSC suite to a formal change control process when these documents are updated. Having considered the generic (i.e. non-specific) nature of the gDSSC documents we are uncertain about how RWMD can implement this in practice. We are also unclear about how such a change control process will ensure that all the different components of RWMD's work will progress smoothly in parallel, taking into account the interactions among them.

5.2.18 In our experience, change control is usually applied to documents that are more tightly constrained than the gDSSC. Change control is useful for making small, discrete changes to a well specified document system. RWMD needs to define in its change control process what constitutes a change. For example, revisions to gDSSC documents may introduce clarifications: would a clarification consistent with a vaguer statement previously made be regarded as a change subject to control? Or do changes subject to control arise only where new statements are introduced that are inconsistent with statements previously made?

5.2.19 RWMD has told us that it is addressing this issue in documents it is currently preparing as part of the Safety Case Manual. We shall review these documents, and the associated change control arrangements, as part of our ongoing scrutiny programme, to determine whether they are consistent with our expectations. This is an important issue to resolve if the gDSSC documents are to be used to support the future development of a GDF and the eventual production of a site-specific DSSC.

5.2.20 We are aware of changes to packaging specifications and the GDF design specification that have already been progressed since the publication of the gDSSC. We think that RWMD should explain how these are being captured under the proposed change control procedure. We shall pursue this matter under our scrutiny programme.

Waste Inventory

A wider exploration of waste inventory uncertainty might be desirable in future revisions of the gDSSC.

5.2.21 Consideration of the overall radioactive waste inventory intended for geological disposal is fundamental, as the inventory controls the size, design and siting of a GDF. The gDSSC examines only two cases, namely the 'derived inventory' and an 'upper inventory'. The 'derived inventory' is based on the 2007 UK Radioactive Waste Inventory and provides a more detailed description of the baseline inventory, which appears in the Government's 2008 White Paper *Managing Radioactive Waste Safely (MRWS)* (Cm 7386) [1]. The 'upper inventory' includes additional wastes that might be generated in the future from a possible programme of new nuclear power stations.

5.2.22 Whilst we recognise that the MRWS White Paper clearly indicates the radioactive waste inventory that should be considered for geological disposal, we also take the view that a wider exploration of inventory uncertainty might be desirable in future revisions of the gDSSC reports. Potential sources of inventory uncertainty include:

- **Uncertainties associated with wastes from a possible programme of new build nuclear power stations**
- **Waste volume/number of packages**
- **Radionuclide and chemical composition**
- **The possible diversion of some wastes to a shallow disposal route.**

5.2.23 We understand that RWMD is already undertaking work to update inventory assumptions, and we welcome this step.

6 Conclusions

We have identified no specific issues that would prevent a safety case, capable of meeting regulatory requirements, being made for a GDF in the future.

6.1 We consider that the broad structure of the gDSSC is acceptable in terms of the general coverage of the documents and of the links shown between them and that the documentation is of generally high quality. The gDSSC provides confidence, to a degree appropriate at this early stage in implementing geological disposal, that a safety case for a GDF in the UK could be made, providing a suitable site is available. Our position is subject to the reservations set out in this review.

6.2 We have identified no specific issues, from our review of the gDSSC, that would prevent a safety case, capable of meeting transport, operational and environmental regulatory requirements, being made for a GDF in the future, providing a suitable site is available and RWMD continues to work with us to address our issues and concerns.

6.3 We have agreed an Issues Resolution Process for our regulatory scrutiny programme with RWMD. Under this process we classify issues that arise from our regulatory scrutiny according to their significance so that they are traceable and can be pursued in the appropriate manner. We shall apply this process, where appropriate, to matters that have emerged from our scrutiny of the gDSSC.

7 Recommendations

7.1 The following recommendations result from ONR and EA's review of the gDSSC. They are provided to help RWMD develop the gDSSC in the future and make progress towards producing an acceptable site-specific safety case for a GDF.

R1. RWMD should explain the future role of the gDSSC and develop a clear route map to show how it might develop the gDSSC towards a site-specific Disposal System Safety Case (DSSC).

R2. There is much repetition and overlap between documents in the gDSSC. RWMD should aim to strike a better balance that will address the needs of different audiences, and help to produce a stable and enduring suite of safety case documents.

R3. RWMD should continue to work towards making the gDSSC reasonably accessible to a wide audience.

R4. RWMD should clarify how it will apply change control to the suite of documents and the statements it contains.

R5. RWMD should include a wider exploration of waste inventory uncertainty in future revisions of the gDSSC.

7.2 We have identified further recommendations that are specific to each regulator's interests. These are listed in Annexes 1, 2 and 3.

References

1. *Managing Radioactive Waste Safely: A Framework for Implementing Geological Disposal* (Cm 7386), TSO, 2008.

2. Safety Assessment Principles for Nuclear Facilities 2006 Edition, HSE, 2006, http://www.hse.gov.uk/nuclear/saps/saps2006.pdf.

3. Environment Agency & Northern Ireland Environment Agency, *Geological Disposal Facilities on Land for Solid Radioactive Wastes: Guidance on Requirements for Authorisation*, February 2009, http://publications.environment-agency.gov.uk/PDF/GEHO0209BPJM-E-E.pdf.

4. NDA, *Geological Disposal: R&D Programme overview – Research and development needs in the preparatory studies phase,* Report no. NDA/RWMD/073, February 2011.

5 *Peer Review of NDA RWMD's Generic Disposal System Safety Case: Analysis of Peer Review Comment Resolution*, 2010-15-1B, Version 1.1, 12 January 2011.

6. NDA, *Geological Disposal: An overview of the generic Disposal System Safety Case*, Report no. NDA/RWMD/010, December 2010.

7. NDA, *Geological Disposal: Radioactive wastes and assessment of the disposability of waste packages*, Report no. NDA/RWMD/039, December 2010.

8. NDA, *Geological Disposal: Generic Transport Safety Case main report*, Report no. NDA/RWMD/019, December 2010.

9. NDA, *Geological Disposal: Generic Operational Safety Case main report*, Report no. NDA/RWMD/020, December 2010.

10. NDA, *Geological Disposal: Generic Environmental Safety Case main report*, Report no. NDA/RWMD/021, December 2010.

Annex 1 Transport Safety Case Review

Review scope

A1-1 For the regulatory review of transport, we reviewed the documents listed at the end of this Annex under 'References'. This is a subset of the documents included overall in the Regulators' review of the 2010 generic DSSC (Main Text, Table 1). The comments in this Annex refer specifically to this subset of documents, although they may sometimes be equally applicable to the gDSSC as a whole. We note that RWMD has said that it intends to update the gDSSC on a rolling basis, by updating individual documents when appropriate.

Summary

A1-2 The overall conclusion reached on this subset of gDSSC documents relates to their overall content, and lack of clarity with regard to strategic principles, objectives and ambitions for the transport aspects of the GDF project.

A1-3 The transport of waste is carried out in the public domain, the volumes of waste are large and the timescales for operation of a GDF are long. Because of these factors, the transport strategy should clearly define strategic principles and ambitions aimed at minimising the number of shipments and the duration of delivery schedules whilst complying with the regulatory requirements that assure safety. Such an approach is not evident from the suite of documents.

A1-4 Much of the content is not new but a demonstration of awareness of existing knowledge. Perhaps this was intentional, but from a regulatory oversight aspect we would expect there to be more strategic goal and ambition setting, with an explanation of how the key components of the waste packaging, storage and transport aspects of a GDF would be managed over decades of time with due recognition of intergenerational issues to be overcome.

Document hierarchy and scope

A1-5 The relationships between the seven reports is unclear and their titles offer little insight into the order in which they should be read to provide an overall view of how the transport issues are embedded strategically into the GDF project.

A1-6 There is no clear definition of the scope and content of each report within the context of the overall gDSSC model. There is too much duplication between the reports and they are not clearly focused on their specific component of the overall GDF project. Consequently, the reader cannot form a clear understanding of each component in appropriate generic/strategic terms with an understanding of how each is managed as the project moves forward.

A1-7 We provide an illustrative example of the topic/strategic component approach in Figure 1. The scope of this diagram, though not exhaustive, provides a means to visualise the expected components of the transport aspects of the project

when reading the reports. Some of the components are of interest to Regulators individually and/or jointly, Government and the wider UK public.

A1-8 Figure 1 has the advantage of enabling the reader to visualise and understand the scope of the project as perceived by RWMD.

A1-9 We recommend including such a figure in the Strategic Level 1 document to act as a road map/index for the report structure, enabling the reader to visualise the scope of issues and topics that RWMD considers necessary to control strategically in a GDF project.

A1-10 By focusing the scope of the reports they can, in some instances, be very concise, easy to read and easy to update individually.

Compliance with transport regulations

A1-11 Demonstration of regulatory compliance is a prerequisite before waste is transported in the public domain but there are also other important considerations to be addressed and managed if the GDF project is to be successful with the intended level of intergenerational public support.

A1-12 Our involvement in the process as transport regulators can provide reassurance to the public that transport of radioactive waste will be carried out in a radiologically safe manner and will meet the requirements of the transport regulations. Assurance of transport safety is based on the safety performance characteristics of individual packages and proper control of the processes for design, manufacture, filling, handling, storage, transport and unloading. In contrast, however, transport will be judged by a wider audience who may take radiological safety as a given and base their views on other factors.

Logistics and infrastructure

A1-13 We have significant concerns about the way the issue of transport is documented in the gDSSC. The Tier 1 document 'Generic Transport Safety Case' [A1.1] seems to suffer from some confusion of purpose. Strategically there is a need for a Tier 2 document but it should be concerned with logistics and infrastructure since transport radiological safety is provided by compliance with the transport regulations, with no need for additional assessment as described in section 1.1 of [A1.1].

A1-14 If the Generic Transport Safety Case was refocused on logistics and infrastructure it could then address the strategic issues of number of shipments, delivery schedules, modes and infrastructure needs, conventional safety, nuisance, environmental impacts (non nuclear) of transport, dose uptake on nuclear sites and the GDF.

A1-15 Radiological safety during transport would be by reference to the Package Design Safety Report (PDSR).

The LoC disposability assessment process

A1-16 Our concern as regulators is that the LoC disposability assessment process should appropriately influence the behaviours of waste producers. The LoC disposability assessment process, together with the regulatory regime

governing waste packaging and conditioning, provides discipline to the production of waste packages. However, a clearer common understanding between RWMD and the waste producers should be developed to ensure that the benefits and risks of the process are in practice being realised and understood.

A1-17 The transformation of the current LoC disposability assessment process into one of a specification of acceptance should be documented so that the consequential risks can be evaluated.

A1-18 The transformation process should be managed and developed, as risk mitigation, in concert with the GDF project. Clearly, the longer wastes remain stored on sites and uncertainties remain about the acceptable waste forms and inventories for a GDF, the greater the risks become that the growing volumes of waste will need further work involving increased dose uptake to operators before they can be transported elsewhere off-site.

A1-19 The context of the LoC disposability assessment process is that waste will be handled and moved away from the sites where it has been stored in a timescale beyond 2040, since that is the notional date when disposal in a GDF begins. This has led to an understanding by the waste producers and RWMD that it is acceptable that package designs for some waste streams will be developed at some stage in the future, thereby taking advantage of best practice at that time. This approach is based on two assumptions, one being that a GDF will definitely be built and in the timescales currently assumed, and the other that the off-site transport of wastes will be in timescales decided entirely by the sites and the GDF. Both these assumptions have risks and require contingency plans for the stored waste to be retrieved and transported to a GDF either earlier or later than the scheduled date. We recognise that there is a high degree of flexibility for waste package retrieval from store and transport to a GDF, resulting from the LoC disposability assessment process. This flexibility is needed to meet contingencies, e.g. substantially delayed retrieval of stored waste, that are not foreseeable in any detailed sense at this stage. The availability of such flexibility needs to be better brought out in revisions to the gTSC.

Data and knowledge management

A1-20 All future off-site transport of wastes must be demonstrably compliant with the transport regulations extant at the time of transport and therefore the waste must be characterised, conditioned, packaged, documented, monitored, inspected and consigned accordingly. This raises particular challenges in terms of intergenerational management of knowledge and records, and the necessary package inspection and despatch testing of packaged waste.

Conclusions

A1-21 With a significant reduction in the overlapping content, more focus on single components of the transport aspects of the project and more strategic setting of principles, ambitions and objectives the suite of documents will provide an invaluable source of information that will enable the project to be subjected to regulatory oversight particularly in the early stages.

A1-22 This effort by RWMD has been worthwhile in that it has focused minds on what is needed and certainly the next effort will be less onerous as the volume of narrative should be much less.

Recommendations

A1-23 The following recommendations result from our review of the transport aspects of the gDSSC. They are made to help RWMD develop the gDSSC in the future and make progress towards producing an acceptable site-specific safety case for a GDF. We have numbered them sequentially following on from those in the main text. They are not in any order of priority.

R6. RWMD should clearly define strategic principles and ambitions in the transport strategy, aimed at minimising the number of shipments and the duration of delivery schedules whilst complying with the regulatory requirements that assure safety.

R7. RWMD should demonstrate a strategic approach to goal and ambition setting and explain how it will manage the key components of the waste generation and transport aspects over a timescale of decades, recognising the intergenerational issues to be overcome.

R8. RWMD should include a diagram in the generic Transport Safety Case (gTSC) Tier 1 document to act as a road map/index for the report structure, enabling the reader to visualise the scope of issues and topics that RWMD considers necessary to control at a strategic level in a GDF project.

R9. Since transport radiological safety is provided by compliance with the transport regulations, RWMD should focus the gTSC on logistics and infrastructure and address strategic issues such as: number of shipments; delivery schedules, modes and infrastructure needs; conventional safety; nuisance; environmental impacts (non nuclear) of transport; and dose uptake on nuclear sites and at the GDF.

R10. RWMD should present contingency plans to ensure that stored waste can be retrieved and transported beyond the scheduled date for delivery to a GDF. RWMD should also present plans setting out the actions and programmes required to enable the waste to be retrieved and transported earlier.

R11. RWMD should present plans to manage knowledge and records so as to ensure that package inspection and despatch testing are carried out in compliance with appropriate transport regulations.

Annex 1 References

A1.1 NDA/RWMD/019, Geological disposal: Generic Transport Safety Case main report.

A1.2 NDA/RWMD/022, Geological disposal: Generic Transport Safety assessment.

A1.3 NDA/RWMD/039, Geological disposal: Radioactive wastes and the assessment of the disposability of waste packages.

A1.4 NDA/RWMD/046, Generic transport system designs.

A1.5 NDA/RWMD/023, Transport Package Safety Report.

A1.6 NDA/RWMD/024, Safety case production and management.

A1.7 NDA/RWMD/031, Package evolution status report.

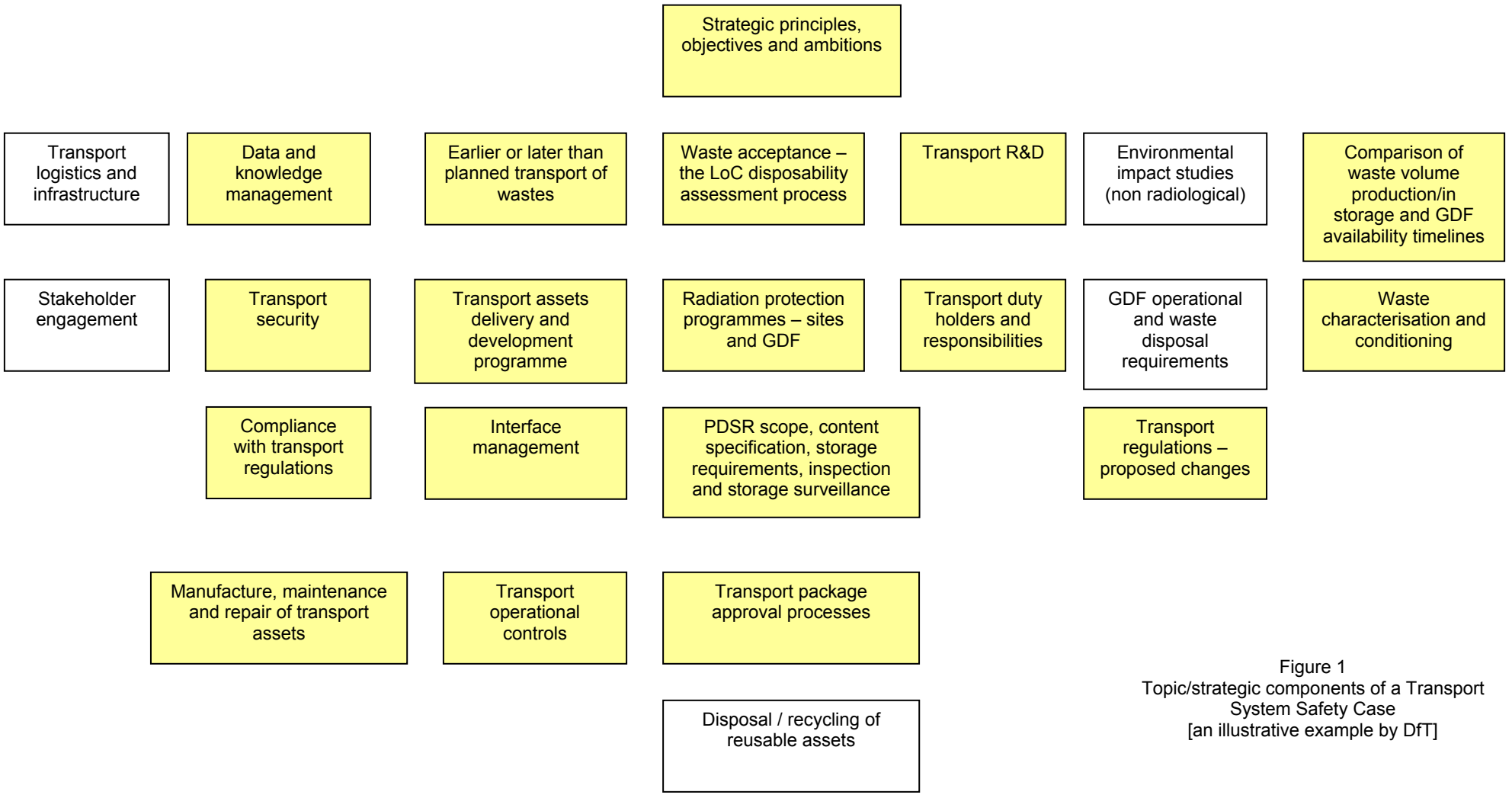

Figure 1
Topic/strategic components of a Transport System Safety Case
[an illustrative example by DfT]

Annex 2 Operational Safety (Including Construction Safety) Case Review

Scope

A2-1 The Operational Safety Case (OSC) [A2.1] is the primary focus for the regulatory review of safety by ONR nuclear safety specialists. ONR inspectors assessed the gDSSC based on sampling aspects of the documents relevant to their specialist areas. To help our assessment we met and asked specialists within RWMD questions about the gDSSC documents [A2.2]. Our assessment aimed to judge whether RWMD has provided an adequate safety submission to give us the necessary confidence that RWMD can manage the long-term risks from the operation of a GDF appropriately.

A2-2 In judging whether the gDSSC is adequate to take geological disposal forward at this early stage in its development, we have sought to:

- Identify whether there are any fundamental issues that would prevent a future safety case for a GDF being made;
- Provide advice and guidance to RWMD on how it can develop the future geological disposal system safety case; and
- Identify specific areas where work is required.

A2-3 As well as reviewing the structure of the safety case presented in the gDSSC, we assessed whether the gDSSC documents achieved the regulatory expectations defined in the HSE Safety Assessment Principles (SAPs) [A2.3] in the following areas:

- Radioactive waste management;
- Civil engineering;
- Mechanical engineering;
- Fault studies;
- Radiological protection;
- Criticality;
- Chemistry and corrosion.

The SAPs provide a framework for assessing safety cases for nuclear safety and radioactive waste management but they do not specifically consider the requirements for disposal facilities. However, they express the regulatory principles against which we would judge a safety case for a GDF and so provide a suitable basis for reviewing the gDSSC.

General Documentation

A2-4 Because the generic OSC (gOSC) is not site-specific RWMD has used illustrative concept examples to examine the safety aspects of a GDF, and the radioactive waste packages, with respect to normal operations and potential accidents. The gOSC focuses on the main operational phase during which radioactive waste packages will be received on site, transported underground and emplaced in the disposal areas. The gOSC also considers safety issues associated with constructing and commissioning the above and below ground facilities, including the separation of construction and waste emplacement activities once a GDF becomes operational.

A2-5 A properly designed and managed process for producing safety cases is key to meeting our overall requirements successfully. The Safety Case Production and Management document within the gDSSC gives little detail in this respect. We understand that RWMD intends to produce a safety case manual. We shall reserve our views on the adequacy of the safety case production and management process until we have reviewed the manual.

A2-6 Although Figure 1 in [A2.1] shows a clear structure of how the higher level reports are underpinned by the Status & Supporting Reports to form the gDSSC, the links between the documents are not always clear. In particular, there is no document that gives a technical overview across the Environmental, Operational and Transport safety case documents, so it is difficult to make judgements on issues that cut across the three safety cases.

A2-7 It is not clear how the gDSSC will be used for setting the baseline for RWMD's future development of a GDF. Nor is it clear what the "management of change process" will be to ensure that all the different components of RWMD's work progress in parallel, taking into account the impacts on each other. We attended a meeting with RWMD to discuss this issue [A2.4]. RWMD informed us that it is producing a suite of documents, as part of its Safety Case manual, that will address the issue. We shall review these documents and the associated arrangements as soon as practicable, to ensure that they comply with our expectations (as given in SC.7 of the SAPs and guidance on compliance with Site Licence Condition 14 [A2.5]). It is important that RWMD resolves this issue if it intends to use the gDSSC documents to support the future development of a GDF and eventual production of a site specific safety case.

A2-8 Operations such as backfilling, closure and decommissioning of a GDF are not considered in any depth in the gDSSC. This is appropriate at this stage because the design detail available at present is insufficient to enable this. However, it is not appropriate for RWMD to state in the OSC that the contribution to risk from these operations will be small just on the basis that they do not involve the physical movement of waste packages. Such a statement needs to be fully justified. RWMD needs to consider the consequences of potential issues, for example, heating of the waste packages and off-gassing during backfilling of vaults with grout. We recognise that heating of waste packages and off-gassing during backfilling is covered to some extent in the generic Operational Environmental Safety Assessment [A2.6], but RWMD needs to consider these issues specifically in relation to their effect on operational safety.

A2-9 In describing the aim of the OSC, RWMD should state that the hazards will be controlled such that risks to the public and workers are broadly acceptable and optimised (ALARP), as stated in the Tolerability of Risk document [A2.7], not just "acceptable" as is currently stated in the OSC.

A2-10 Assumptions in the gDSSC relating to the radioactive waste inventory need to be reviewed, particularly given new developments since the Managing Radioactive Waste Safely White Paper was issued. We understand that RWMD is already undertaking work to update inventory considerations. The inventory controls the size, design and siting of a GDF; and we stress that RWMD should not underestimate the importance of the inventory information used.

Civil Engineering [A2.8]

A2-11 An unusual feature of a GDF is that construction is likely to progress in parallel with operation (waste emplacement). This could lead to various fault scenarios in which construction impinges on operation or vice versa. RWMD will need to monitor this very closely, particularly with regard to the selection of the construction method, because of the potential risks involved. There could also be events during construction and operation that could affect post-closure safety, which RWMD will need to assess. If construction and emplacement activities occur at the same time, they will need to be serviced by completely separate ventilation systems and services to minimise the potential for unplanned interactions between the activities. RWMD will also need to assess the potential effects of vibration from blasting and construction, on operations and post-closure safety. This is also intrinsically linked to the geology and construction sequencing. We consider that these are important areas where more consideration could be given in the OSC and its primary supporting document on safety during construction [A2.9].

A2-12 RWMD's document on Safety, Environmental, Security and Safeguards Principles for the Design Process [A2.10] gives some detail on the design codes and nuclear industry guidance to be used in the development of a GDF. However, it does not give adequate cognisance to the importance of detailed design issues related to nuclear structures. The incorporation of regulatory expectations on this topic have not been sufficiently covered in the gDSSC. RWMD should undertake formal reviews at suitable planned stages to confirm the validity of the design, to act as a forum for information transfer, to identify potential problem areas and to highlight regulatory expectations. During the production of the detailed design, the reviews should as a minimum include whether:

- Appropriate design acceptance criteria have been established and are being met.
- The safety justification process is integrated into the design process.
- Correct codes and design parameters have been established.
- The design identifies appropriate materials and products.
- Appropriate and referenced design documentation is being produced.
- The design identifies suitable limits and conditions of operation and safety.
- The design addresses the issue of longevity and resilience.
- The examination, inspection, maintenance and testing (EIMT) regime is fully integrated.

A2-13 Effective protection against groundwater ingress will be important, both for the safety of workers during construction and to prevent flooding and degradation of the structure during the subsequent emplacement and monitoring phases. This would be a key issue in any evaporite geology since undetected non-saturated groundwater ingress, following construction, could potentially dissolve affected parts of the excavated openings or corrode equipment. The management of groundwater ingress during construction and operation of a GDF is an area that needs far more work in the future development of the gDSSC.

A2-14 When considering the optimum design for a facility it is particularly important to consider ageing and degradation (asset management), given the potentially very long operating lifetime of a GDF. To support this, the design process should identify and address the requirements for examining, inspecting, maintaining and testing structures, systems and components to assure their continued safe operation. Due regard should be given during the design process to visibility and accessibility of structures, systems and components to meet this requirement. With operating requirements of potentially over a hundred years, specific attention should also be paid to facilitating the replacement of items which are intended to be renewed within the design life of the overall facility. Licence Condition 28 has particular relevance to this issue. The SAPs EMT series (maintenance, inspection and testing) and WENRA Reference Level K (Maintenance, In-service Inspection and Functional Testing) are applicable to the interface with maintenance and inspection.

Fault Studies [A2.11]

A2-15 Within the gOSC and supporting documents, RWMD has used a 'partially protected' approach (claimed passive mitigation) to decide the unmitigated consequence. Whilst we recognise that this approach is useful as a first pass, we stress that, if used wrongly, it could cause incorrect categorisation of safety functions leading to incorrect classification of engineering. It is essential to understand the unprotected radiological consequence to develop suitable and sufficient mechanical equipment to deliver safety functions (ONR SAPs - FA.1 to FA.9).

A2-16 We think that the use of a 'partially protected' approach in the gOSC may have affected derivation of the bounding case faults, in terms of the unmitigated consequences to workers and members of the public. The gOSC suggests that the bounding radiological consequence appeared to come from ILW type package faults. If the unprotected radiological consequences are considered this can be challenged, as design basis faults to other waste packages (for example HLW packages) could potentially lead to higher radiological consequence with a greater functional requirement demand for safety.

A2-17 We consider that the use of the "partially protected" and "fully protected" dose concepts at this preliminary stage is potentially misleading when applied to the identification of design basis faults. If this approach is used at the more detailed design stage, it may give misleading results for faults which are truly design basis faults, but which may not be regarded as design basis faults using the current approach.

A2-18 Following the Fukushima disaster, we have undertaken a detailed review of the design standards required for the assessment of external hazards for UK nuclear facilities. The Fukushima disaster has focused attention on seismic events and tsunamis, but all credible external events will be considered. RWMD

should familiarise itself with the findings of our report [A2.12], and, if necessary, modify the standards currently used to assess external hazards.

A2-19 The only significant external radiation fault for which demonstration of compliance with the 20 mSv Basic Safety Level (BSL) cannot yet be demonstrated is the inadvertent exposure of a maintenance worker to a bare Unshielded ILW (UILW) package in a Standard Waste Transfer Container (SWTC) which was believed to be empty. This could occur where, for example, a SWTC is returned to the surface without having had the waste package removed. Currently, the only engineered safety system to prevent this is gamma monitors installed at the maintenance facilities. These would be backed up by managerial controls such as radiation surveys on SWTCs received at the maintenance facility. There would also be inventory accountancy controls for tracking all waste packages, designed to prevent a package being mistakenly returned to the surface. The option of an additional engineered safety system, such as an interlock (possibly based on container weight) to prevent inadvertent export of a loaded SWTC from the inlet cell is discussed in [A2.1]. However, RWMD needs to give further consideration to engineered systems which prevent inadvertent worker exposure in the event of this fault.

A2-20 The thermal response of waste packages to fire is discussed extensively in section 6 of reference [A2.13]. It gives results from experiments and finite element heat transfer models on packages containing simulated waste for an extreme bounding fire fault scenario (1 hour at 1000ºC). However, we consider that RWMD needs to justify the fire resistance of ILW waste packages, because of the U/Mg swarf content of a number of the these packages. This could be done using the results of actual experiments, as well as detailed 3-D finite-element heat transfer models. Similarly, detailed 3-D heat transfer models for all possible ILW packages under extreme fire scenarios, coupled with an in-depth assessment of any possible adverse waste/grout chemical reactions, may help to provide assurance of the package integrity during extreme fire fault conditions and make the gDSSC more robust. The emphasis of the current safety case is to reduce the quantities of flammable materials inside the repository to levels such that the most onerous fire event involving the ILW containers is extremely unlikely either to occur or to be sustained for a significant length of time. However, the OSC should, in the future, give consideration to fire suppression systems in the ILW underground vaults which would be able to extinguish any fire hazards envisaged in the design of a GDF safely and rapidly.

A2-21 ILW waste consisting of Magnox swarf often contains uranium metal pieces, either in the form of swarf or bulk sections of fuel rod. On the basis of the preliminary findings reported in [A2.14], there are significant uncertainties in the corrosion rates of encapsulated Magnox swarf and U metal pieces, and therefore the rate of heat and gas generation. Some older ILW drums containing U metal are showing significant localized swelling of the drum surface, thought to be due to the corrosion (and subsequent expansion) of encapsulated bulk U metal pieces. RWMD will need to provide further detailed arguments in the OSC to justify the long-term chemical stability of cement-encapsulated Magnox and U in ILW containers for the long operational period of the GDF.

A2-22 The gOSC considers a HLW or spent fuel disposal canister in a steel Disposal Canister Transport Container (DCTC) in a scenario of 1 hour in a 1000ºC fire. Under these conditions the copper disposal canister might reach a temperature well in excess of its creep temperature, with the possibility of deformation under the mechanical load due to the container contents, or even the mass of the

copper itself. From this we can identify a possible fault scenario whereby the disposal canister is stuck in the DCTC, and subsequent fault scenarios resulting from trying to remove a stuck disposal canister for burial with the potential for high operator doses or the possibility of having a DCTC that can never be emptied of its inner disposal canister. If a GDF is designed with fixed disposal canister geometries for HLW and spent fuel, in terms of mechanical manipulators, crane maximum loads, access space, etc., then the resulting DCTC may be too large to be disposed of. This potential fault is not considered in the current fault analysis reports, but should be covered in the future development of the gDSSC.

A2-23 The rigour and depth of the analysis in the Waste Package Accident Performance Report [A2.12] gives adequate assurance that the integrity of both UILW and shielded ILW (SILW) waste packages would not be compromised by even the most onerous drop fault scenarios on to a flat surface. However, the gDSSC does not provide sufficient information on the integrity of packages dropped on to sharp protrusions, angular edges and so on, rather than simple flat surfaces. RWMD should address this in the future development of the gDSSC. Also, RWMD should consider possible ALARP measures to reduce the dispersion of any particulates produced by an impact forceful enough to breach an ILW container, which could lead to an airborne contamination hazard.

Mechanical Engineering [A2.15]

A2-24 The ventilation scheme proposed for a GDF during its operation consists solely of a HEPA type particulate filtration system. This could be subject to a number of design basis challenges in term of potential radiological discharges and hazardous gas generation (for example, hydrogen and carbon-14). RWMD needs to carry out further work to substantiate the use of this system, given the current uncertainty associated with gas generation in a GDF, and that the ventilation system should be fit for purpose and may need to be capable of managing a range of potential gaseous challenges (SAPs - ECV.1 to ECV.10). In particular, account should be taken of the following:

- HEPA filters offer little protection against radiological gaseous type discharges.
- Hazardous (potentially explosive) gas would require appropriate management.

A2-25 Appropriate consideration needs to be given to managing the removal of heat for the range of waste packages (SAPs - EHT.1 to EHT.5). During interim storage, before transfer to a GDF, the maximum temperature of waste packages is subject to strict limits and is controlled by, for example, natural or forced air circulation. This is important to minimise corrosion of the waste packages and maintain their integrity. Given the long operational lifetime of a GDF and the potential requirement to retrieve waste packages during this period, it is important that environmental conditions within the repository are optimised to maintain the integrity of the waste packages and the usability of their handling fixtures, or that packages are designed to withstand the range of environmental conditions they will experience in a repository. The link between the maximum operating temperature of the waste packages and the design of various mechanical equipment needs to be further developed in the gDSSC.

A2-26 Within the gOSC no claims are made for what events the various waste packages will withstand. Consequently, a radiological release is assumed in the

event of a challenge to the waste packages. This implies a 10E-4 probability of failure on demand (pfd) claim against lifting equipment to safeguard against a dropped load (although the gOSC does not explicitly make this claim). In discussion RWMD was unable to verify the extent of the pfd claims across the range of GDF mechanical equipment. During the future development of gDSSC RWMD should :

- Consider equipment reliability claims, which may be limited by common cause failures (SAPs ERL.1 to ERL.4);
- Pay particular attention to high reliability claims if used to claim that the initiating event is outside the design basis (SAPs EMC.1 to EMC.3 would be normally be invoked).

Radiological Protection [A2.16]

A2-27 The facility is designed to be able to store one week's worth of packages above ground if for whatever reason the GDF became unavailable. However, the public and worker doses that may be obtained from a prolonged shutdown have not been calculated. Assessed public doses were based on the assumption that the worst case will be 12 wagons in the siding during transit. The trailer park also has a capacity for up to 26 trailers. The assessment assumes these will not contribute significantly to public doses because they are transitory. We can envisage a scenario where this may not be the case, during a prolonged shutdown of the underground facilities, and we think that RWMD should consider the potential public and worker dose from these.

A2-28 The gDSSC should demonstrate that worker doses obtained during SILW package emplacement (0.9mSv high strength rock and 1.22mSv in low strength rock) have been minimised to ALARP levels. RWMD could achieve this by, for example, considering the use of more automation, or backfilling as part of the emplacement process rather than waiting until the vault is full.

A2-29 The procedures for monitoring and accepting SILW packages and UILW packages within their transport containers is clearly described. However, it is not clear what checks are made on UILW once they are removed from their transport containers or what actions would be undertaken if they were found to be contaminated or defective. This needs to be rectified to give the full view of how the WAC will be implemented and the safety case protected.

A2-30 The example operator dose assessments given in the gOSC concentrate on package handling and emplacement operations. The maintenance programme of a GDF, before backfilling/closure, will need to address retrieval of any defective or degrading packages. This has not been considered in the gDSSC. RWMD needs to assess the consequences of retrieval, clean-up of any contamination spills, reconditioning of waste packages and re-emplacement, which would all result in increased dose to operators.

A2-31 With respect to operator doses and discharges to the environment, the gDSSC documents tend to focus on target values, legal limits and modern standards, without adequate consideration of ALARP to put these into context. RWMD will need to strengthen the ALARP arguments presented in the gDSSC in the future, when there is more detailed dose and discharge information to work with.

A2-32 The discussion on optimisation in the gDSSC needs to consider the effects of partially filled packages on a GDF and whether limits on voidage in packages

are required. Reducing voidage could mean that fewer packages are needed and hence overall dose from the operation of a GDF could be reduced.

Criticality [A2.17]

A2-33 The criticality safety case for a GDF has not yet been developed in detail, so it was difficult to carry out a thorough assessment of the criticality issues covered in the gDSSC. However, we find the approach being adopted by RWMD, involving the identification of criticality hazards through HAZOP studies, and the subsequent production of a detailed criticality safety case using proven methodologies, acceptable, provided RWMD addresses the following two issues in future versions of the gDSSC.

A2-34 In the gDSSC Criticality Safety Assessment document [A2.17], burn up credit (BUC) is used to make the criticality safety case for the disposal of spent reactor fuel in a GDF. A final decision on this approach has not yet been made. However, if RWMD decides to use this approach, then very detailed, high quality records for the irradiation history of the fuel will be required in order to substantiate the BUC arguments. The records will need to demonstrate that the irradiation of the fuel is at least as high as that claimed in the criticality safety case.

A2-35 It is noted in [A2.19] that BUC has been used in some other countries in making criticality safety arguments for the geological disposal of spent reactor fuel. However, it has not been widely used for making criticality safety cases in the UK. To support such a case consideration should be given to either the use of an irradiation monitor, to give confidence in the BUC arguments, or provision of fixed neutron poisons, to reduce the reactivity of the spent fuel. However, if neutron poisons are added to spent fuel packages, then consideration should be given to fault sequences that could lead to the fuel being separated from the poisons, e.g. energetic impact events.

A2-36 RWMD states in [A2.1] that it believes it will be able to make an omission case such that a Criticality Warning System (CWS) is not required. This is based on the fact that the waste packages will need to satisfy the IAEA Transport Regulations, which require deterministic safety justifications for normal operations and a number of pessimistic contingencies. However, RWMD recognises that it will need to consider over-batching scenarios, where the consigner incorporates excessive amounts of fissile material in the waste packages beyond that allowed by the CfA. Given that the design of the GDF has not yet been developed in detail and the cost of a CWS system would be minor compared to the overall cost of a GDF, RWMD will need to make an ALARP case for the exclusion of a CWS.

Chemistry and Corrosion [A2.20]

A2-37 The gDSSC documents, in particular the Package Evolution Status Report [A2.21], identify a range of factors affecting corrosion. However, there are still a number of uncertainties with respect to the conditioning of certain wastes, packaging material and design of a GDF, that will require further development of the understanding of corrosion processes as more information becomes available: for example, consideration of the potential for galvanic corrosion from the use of two different metals, as in the concept for HLW to be contained within stainless steel canisters inside a copper overpack.

A2-38 In the future development of the gDSSC, RWMD needs to consider further the radiolysis of water in contact with the surface of waste containers and its impact on the corrosion rate, e.g. the potential to generate hydrogen peroxide and increase corrosion rate, to support the safety case.

A2-39 [A2.21] draws on international experience to provide evidence to support waste package durability and there is experience of demonstrating the durability of ILW/LLW waste packages in the UK (limited to around 20 years). However, extensive further work will be required to demonstrate the longevity of ILW/LLW waste packages over the proposed timescales required for a GDF (500 yrs). RWMD needs to determine what evidence is required and how the organisation will acquire it.

A2-40 As noted in Paragraph A2-25, the environmental conditions (temperature/humidity/pH) within the GDF vaults will need to be adequately defined in future safety documentation to ensure that the integrity of waste packages is optimised. We recognise that detailed information relating to, for example, the site, concept and design will need to be considered in the future in order to develop a regime to monitor the integrity of waste packages during the operational phase.

A2-41 The main mechanisms by which gas could be generated in a GDF are described in the Gas Status Report [A2.22]. We recognise that these mechanisms are widely accepted and that the report draws on international experience and participation in the research at the Aspo Hard Rock Laboratory in Sweden. We note that the environmental conditions in which the waste packages are stored will need to be adequately defined, controlled, monitored and maintained to minimise gas generation. Any gases produced will need to be sufficiently well ventilated to minimise doses to the operators and to ensure that there is no unacceptable build up of gas pressure within the repository that may cause damage to the engineered barrier system of the GDF or the host geology.

Conclusions

A2-42 No issues have been identified within the gDSSC that would prevent an operational safety case being made for a GDF in the future that would meet regulatory requirements, should a suitable site be identified. This review provides advice and comment to RWMD on matters within ONR's safety regulatory remits; it does not form the basis of any regulatory decision.

A2-43 Whilst we are content with the broad structure of the gDSSC, we have concerns about the linkages between documents and the complexity of bringing these together to demonstrate an overall safety case for a GDF at a technical level, as well as to a wider audience. We are also at present unclear how RWMD will manage the development of the gDSSC and how it will be used to support future development of a GDF. We have discussed this issue with RWMD and we will monitor it through the ongoing Regulators' Scrutiny Programme for the development of a GDF.

A2-44 We are broadly satisfied with the claims, arguments and evidence laid down in the gDSSC, as far as can be expected for a generic safety case for a GDF with no specific site or design. However, we have listed below a number of recommendations relating to areas where RWMD will have to undertake more work to produce a safety case for a future GDF. RWMD is aware of the majority of these and has plans in place to address them.

Recommendations

A2-45 The following recommendations result from ONR's review of the gDSSC. They are made to help RWMD develop the gDSSC in the future and make progress towards producing an acceptable site-specific safety case for a GDF. We have numbered them sequentially following on from those in Annex 1. They are not in any order of priority.

R12. Provide a simple waste route diagram that shows the various routes for the different waste streams within a GDF.

R13. Provide a summary document that pulls together various components from the suite of gDSSC documents and presents a coherent safety case to a technical audience.

R14. Provide a Safety Case Manual and a quality assured documentation procedure for the development and management of a safety case for a GDF.

R15. Ensure that RWMD's "management of change process" is progressively adapted to be fit for purpose for future stages of the programme so that all the different components of RWMD's work progress in parallel.

R16. Develop a more detailed understanding of the safety implications of operations such as backfilling, closure and decommissioning of a GDF, to substantiate the claim that they only make a small contribution to the risk from operations of a GDF.

R17. Take into account the most up to date inventory considerations in the future development of the gDSSC.

R18. Consider the impact of construction methods with regard to vibration.

R19. Consider the impact of construction methods on sequencing and emplacement of waste packages.

R20. Consider the requirement for design reviews and regulatory expectations with regard to change management to ensure that the validity of the design is maintained as it develops.

R21. Consider regulatory expectations, as described in the HSE Safety Assessment Principles (SAPs), with respect to examination, inspection, maintenance and testing (EIMT), asset management, longevity and ageing/degradation.

R22. Consider unprotected radiological fault consequences within the design basis.

R23. Consider the lesson learnt from the Fukushima disaster with respect to the assessment of external hazards for UK nuclear facilities and if necessary, modify the standards used to assess external hazards from those currently quoted in the SAPs.

R24. Consider further the need for engineered systems to prevent inadvertent exposure of a maintenance worker to a bare unshielded ILW package in a standard waste transfer container which was believed to be empty and returned the surface.

R25. Consider fire suppression systems in the ILW underground vaults which would be able to extinguish safely and rapidly any fire hazards envisaged in the design of a GDF.

R26. Provide more detail to justify the long-term chemical stability of cement-encapsulated Magnox and uranium in ILW containers, for the long operational period of a GDF prior to its backfilling and closure.

R27. Consider how the potential fault of a HLW or spent fuel disposal canister being stuck in a steel disposal canister transport container, as a result of a fire, would be managed.

R28. Provide more information on the integrity of packages dropped on to sharp protrusions, angular edges and so on, rather than simple flat surfaces, and consider the ALARP measures that could be used to reduce the dispersion of any particulates produced by the impact.

R29. Consider in more detail the requirements for radiological and hazardous gas management.

R30. Consider in more detail the requirements for managing the removal of heat from a GDF.

R31. Consider regulatory expectations with respect to claims of high reliability.

R32. Consider in more detail limits on voidage in packages and the effect of partially filled packages on the facility and operator doses.

R33. Consider in more detail work on maintenance activities in terms of extended operations and the impact of increased dose to workers.

R34. Provide more detail on how the Conditions for Acceptance (CfA) will be implemented for unshielded ILW packages after they have been removed from the transport containers.

R35. Strengthen the ALARP arguments presented in the gDSSC, when there is more detailed dose and discharge information to work with, and demonstrate how these are made across the documents that make up the gDSSC.

R36. Identify the requirement for detailed records to demonstrate that the irradiation of the fuel is at least at high as that claimed to support the burn up credit (BUC) in the criticality safety case.

R37. Consider either the use of an irradiation monitor to give confidence in the BUC arguments for disposal of fuel or provision of fixed neutron poisons to reduce the reactivity of the spent fuel.

R38. Consider the use of a criticality warning system or provide an ALARP case for its exclusion.

R39. Consider in more detail radiolysis of water in contact with the surface of waste containers and its impact on the corrosion rate.

R40. Consider what further information is required to demonstrate the longevity of ILW/LLW waste packages over the proposed timescales required for a GDF (500 yrs) and how RWMD will acquire it.

R41. Consider the impact that defining the environmental conditions to store the waste packages in a GDF will have on:

- minimising gas generation
- enabling any gases produced to be sufficiently ventilated to minimise doses to the operators
- preventing an unacceptable build up of gas pressure within the repository that may cause damage to the engineered barrier system or the host geology.

R42. Develop and define a regime to monitor the integrity of waste packages during the operational phase of a GDF.

Annex 2 References

A2.1 Geological Disposal: Generic Operational Safety Case Main report, NDA RWMD, NDA/RWMD/020, 2010.

A2.2 Contact report for Topic Day with RWMD to support ONR assesment of the Geological Disposal facility generic Disposal System Safety Case, Harwell,16th June 2011, ONR-D2-NSS-IR-11-053

A2.3 Safety Assessment Principles for Nuclear Facilities 2006 Edition, HSE, 2006, http://www.hse.gov.uk/nuclear/saps/saps2006.pdf

A2.4 Contact Report for RWMD/Regulator Meeting on Change Control, Harwell, 17th May 2011, IR-ONR-D2-NSS-IR-11-016

A2.5 LC 14 Safety Documentation Technical Inspection Guidance, HSE, T/INS/014 Issue 1, 2003 http://www.hse.gov.uk/foi/internalops/nsd/tech_insp_guides/tins14.htm

A2.6 Geological Disposal: Operational Environmental Safety Assessment, NDA RWMD, NDA/RWMD/029, 2010.

A2.7 The Tolerability of Risk from Nuclear Power Stations, HSE, 1992, http://www.hse.gov.uk/nuclear/tolerability.pdf

A2.8 CS&A Assessment of the Geological Repository Documentation, ONR, ONR 2011/AR0078.

A2.9 Geological Disposal: Generic Safety Assessment – Volume 1 – Construction and non–radiological safety assessment, NDA RWMD, NDA/RWMD/025, 2010.

A2.10 Safety, Environmental, Security and Safeguards Principles for the Design Process, NDA RWMD, Technical Note 9228189, 2009.

A2.11 Geological Repository Fault Studies Assessment, ONR, AR ZZ/DD.

A2.12 Japanese earthquake and tsunami: Implications for the UK nuclear industry. Final Report HM Chief Inspector of Nuclear Installations. September 2011. http://www.hse.gov.uk/nuclear/fukushima/final-report.pdf

A2.13 Geological Disposal - Waste package accident performance status report, NDA RWMD, NDA/RWMD/032, Dec. 2010.

A2.14 Status of the Letters of Compliance for Waste Packages Manufactured by the Magnox Encapsulation Plant, NDA RWMD, LL13031421, Sep. 2010.

A2.15 Mechanical Assessment of Geological Repository, ONR, 2011/AR11068.

A2.16 Radiological Protection Assessment of Generic Operational Safety Case Report for Generic Disposal Facility, ONR, 2011/AR11066.

A2.17 Generic Disposal System Safety Case Criticality Safety Assessment, ONR, 2011/AR11052.

A2.18 Generic Operational Safety Assessment, Volume 4, Criticality Safety Assessment, NDA RWMD, NDA/RWMD/028, Rev 1, November 2010.

A2.19 Criticality Safety Status Report, NDA RWMD, NDA/RWMD/038, December 2010.

A2.20 Generic Disposal System Safety Case Corrosion Assessment, ONR, 2011/AR11089.

A2.21 Geological Disposal: Package Evolution Status Report, December NDA RWMD, NDA/RWMD/031, 2010.

A2.22 Geological Disposal: Gas Status Report, NDA RWMD, NDA/RWMD/037, December 2010

Annex 3 Environmental Safety Case Review

Context, Purpose & Scope

Context

A3-1 Our regulatory guidance, the GRA [A3.1], does not specify a need for a generic ESC. We assume a progressive development, from a zero baseline, of a site-specific ESC. The guidance provided by the GRA cannot be applied directly to the gESC: not all parts of it may be applicable at the present stage, and some parts that are applicable may need to be interpreted.

Purpose

A3-2 The purpose of the Environment Agency's review of the gDSSC at this stage is to:

- identify whether, in our opinion, there are any issues arising from the gDSSC that could cause problems when we consider any future application for permitting purposes.
- provide guidance to RWMD on regulatory matters to help it:
- improve future documents, including future development of the generic environmental safety case (gESC) within the wider context of the developing gDSSC;
- develop any future site-specific environmental safety case (ESC) for geological disposal, that is fit for purpose and demonstrates optimised environmental and safety performance in accordance with regulatory requirements.
- keep ourselves informed and thereby improve the basis on which we are able to provide early advice to other parties, such as Government, the West Cumbria MRWS Partnership and the planning authorities.
- satisfy ourselves that advice given to licensees about waste packaging is suitably underpinned to reduce the potential for repackaging in the future.
- identify any gaps in the documentation, understanding and reasoning in the gDSSC, or in the work that supports it, and explain what we would expect RWMD to do to close any such gaps.

Scope

A3-3 We do not require a gESC as part of our regulatory process, and not all areas of our guidance (GRA [A3.1]) are fully applicable at this stage.

A3.4 Our review of the gESC is based around answering five questions:

1. Does the content of the gDSSC provide an appropriate basis for future assessments and endorsements through the LoC disposability assessment process?

2. Is RWMD's strategy for the development and use of the gDSSC in the MRWS site selection process consistent with our expectations?

3. Does RWMD set out a credible route to achieving the R&D underpinning necessary to support a full site-specific safety case and accurately reflect progress to date?

4. Are the scope, format and types of content of the gDSSC consistent with our expectations for a GDF environmental safety case?

5. Does the gDSSC confirm or modify our 2005 conclusion [A3.2] on Nirex's Viability Report [A3.3]? *"…it is feasible in the medium term that a safety case could be generated that would meet regulatory requirements, provided a publicly and technically suitable site were available."*

General Comments

Accessibility to a Technical Audience

A3-5 The gESC main report [A3.4], is a difficult read even for a technical audience. This is not because of its technical content, but because of its unwieldy structure, unevenness of detail, inconsistencies and internal repetition. We consider that these are signs of inadequate or unsuitable editorial control. Since the gESC and the gDSSC as a whole will remain current for an extended period, it may be worth improving their accessibility to technical audiences and, where feasible, to wider audiences.

A3-6 RWMD has a large, rolling programme of documents to produce, against a background of changing circumstances and developing thoughts. We would encourage RWMD to produce documents that are more tightly structured and focused, and less repetitive. We think that putting effort into better editorial control will help RWMD present its work more clearly and understandably to different audiences. Furthermore, we would encourage RWMD to apply improved editorial control not only to individual documents but also to the whole RWMD structure of documents, both within and outside the gDSSC.

A3-7 We would encourage RWMD to ensure that the internal structure of documents, as well as the overall structure of suites of documents such as the gDSSC and any site-specific DSSC, is no more complex than it needs to be. This will help to make future documentation clearer, more consistent and more convenient to the user. We would not wish to see a proliferation of documents as a result of adding new documents to describe extensions or changes to the work.

Post-Closure Safety Assessments

A3-8 Given the abstract and stylised nature of the illustrative post-closure safety assessments set out in the generic Post-closure Safety Assessment (gPCSA) report [A3.5], it is not appropriate for us to make detailed comments. The illustrative assessments are based on a simplified geological setting of higher strength host rock under sedimentary cover with a choice of key parameters within ranges that RWMD considers are reasonable. The assessments do not represent the details of an actual site and it is difficult to draw any firm inferences from them. However, they suggest that, in principle, it would be possible to construct an ESC that broadly meets regulatory requirements. While we note the statement in the gPCSA, "*The parameter values for the reference case have been chosen such that the total peak risk is likely to be close to the risk guidance level*" [ref , Section 5.2.2, p.55], we would wish to see a clear statement in the gESC documents about the limitations of the assessments.

The gDSSC & the LoC Disposability Assessment Process

Links Between the gESC & LoC Disposability Assessment Process

A3-9 We expect RWMD to ensure that as the gESC develops it is appropriately linked, through the LoC disposability assessment process, to advice on waste packaging arrangements given to waste producers and owners. We wanted to understand the interaction between the gDSSC and the developing LoC disposability assessment process. In order to do this, we had to consult documents, not included in the gDSSC suite, that provide generic guidance on waste packaging. The gDSSC should contain enough information to give at least a basic understanding of all important aspects of the safety case (of which this is one).

A3-10 We will review future documents, when these are available, as part of our ongoing scrutiny of RWMD's work to determine how they contribute to explaining how the gESC interacts with disposability assessments, packaging advice and endorsements through the LoC disposability assessment process.

Use of gESC Assessments in Underpinning Advice to Waste Producers

A3-11 The gESC main report [A3.4] makes extensive reference to the results of generic quantitative post-closure safety assessments (more fully described in the gPCSA [A3.5]), but there is little evidence of quantitative underpinning of the LoC disposability assessment process. The gESC documentation describes a five-parameter quantitative assessment process for the groundwater pathway

but, of these five parameters, four[i] do not relate to the properties of waste packages.

A3-12 The fifth parameter, C, the time taken for failure of the waste container, does relate to the properties of waste packages, but it is a simplified representation that merely introduces a time delay before radionuclides begin to be released from a GDF. RWMD has explored the effect of including this parameter mainly for high level waste and for spent fuel canisters. The gPCSA assumes for the parameter C a central value of 500,000 years (representing copper container material) in its reference case and a value of 10,000 years (representing shorter-lived container material such as steel) in variant scenarios. The range of sensitivity of the C parameter that RWMD has explored (an order of magnitude variation either way) is not linked to evidence in the package evolution status report. RWMD states, however, that given the current generic stage of its programme, the calculations should be regarded as providing only indicative information; and that specific research and development aimed at determining appropriate parameter values for the safety functions of a GDF in the UK will be carried out as and when a disposal site has been identified.

A3-13 In discussion, RWMD has agreed that its disposability assessments are mainly based on qualitative criteria; and that this approach, while broadly consistent with quantitative assessments, does not rely on them. We accept that this is a reasonable, practical approach at the current stage of the geological disposal programme. The gESC, however, gives a misleading impression of providing a primarily quantitative basis for the LoC disposability assessment process and obscures the reasonable, qualitative criteria that RWMD is mainly applying. We expect future revisions of the gESC documents to correct this misleading impression.

A3-14 Our view of the approach to packaging advice presented in the gESC is that at this stage it represents a screening approach for waste acceptance, and a confidence-building and risk-reduction tool. The existing LoC disposability assessment process is broadly robust, but we recognise that it has limitations since no site for geological disposal has been identified, and that it will be subject to improvement.

Aligning LoC Disposability Assessment Process with Future Development of Waste Acceptance Criteria

A3-15 At present, without any identified site for geological disposal, RWMD is inevitably a long way from being able to formulate WAC, and especially those aspects of the WAC that derive from the ESC. We consider that there could be

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[i] These parameters are: q, the specific discharge of groundwater through the undisturbed host rock at the location of a GDF; T, the groundwater travel time from a GDF to the surface; F, the groundwater mixing flux in the overlying rocks into which the contaminated groundwater plume leaving a GDF may eventually rise from depth and mix; and A, the discharge area into which the contaminant plume is released at the surface.

advantages in beginning to define a 'road map' towards developing WAC, with milestones perhaps aligned with MRWS stages.

A3-16 We would expect WAC to include acceptance criteria for chemotoxic and hazardous substances in order to protect groundwater resources and human health in the post-closure period. This matter is not addressed in the gESC. RWMD should develop generic restrictions on chemotoxic and hazardous substances, in accordance with statutory requirements for groundwater protection.

A3-17 We would encourage RWMD to clarify which waste criteria are based on generic performance requirements, by providing a list of the generic qualitative constraints on waste packaging, together with an explanation in each case of how the constraint arises.

Use of Specific Waste Package Information as Basis for ESC

A3-18 The gESC does not recognise the uncertainty relating to possible differences between the radionuclide content of wastes as specified in the UK Radioactive Waste Inventory (UKRWI) and the measured radionuclide content of wastes as packaged. At closure of a GDF, we would expect the ESC to be based on the inventory as disposed of (based on waste package records adjusted to account for radioactive decay). RWMD needs to explain how it will progress from using the published UKRWI as the basis for the ESC to using waste package information.

Strategy for Development & Use of the gESC in MRWS Site Selection Process

Strategy for Developing the gESC

A3-19 The gESC main report [A3.4] says that "*the purpose of the [generic] DSSC is to illustrate how [RWMD] could make a safety case at candidate sites having different geological environments, and to understand the features of particular environments and disposal concepts that would need to be investigated*" (Section 6.2, p.164). This statement is consistent with our expectations but it is not clear how the link to the MRWS site selection process will be realised in practice.

A3-20 We recognise that the gESC may provide a useful rehearsal for at least some aspects of how safety arguments might be presented for any future site-specific cases. Regarding the Generic Post-Closure Safety Assessment [A3.5], we accept that some scoping calculations are appropriate at the present stage to support the general proposition that geological disposal of higher activity radioactive wastes in an environmentally safe manner is feasible. We are concerned, however, that some readers might interpret the gESC as providing a generalised environmental safety case for geological disposal, which then simply needs to be refined to provide a site-specific case. As indicated in the main text of this report, it is not clear from the gESC how RWMD might develop any future site-specific ESC: this needs to be carefully mapped out.

gESC Description of Route for Implementing Safety Strategy

A3-21 The nature of the submissions to us at Stages 4 and 5 of the MRWS process, as described in Section 2 of the gESC main report [A3.4] are unclear. Section 2.1 does not distinguish clearly between an ESC, an Initial Site Evaluation (ISE) and a Preliminary Environmental Safety Evaluation (PESE), all concepts drawn from the GRA [A3.1]. Section 2.1 introduces a new term 'site assessment', which is undefined. We shall work with RWMD, through our continuing scrutiny programme, to ensure that future submissions are in line with our expectations.

A3-22 UK Government is consulting on the framework to identify and assess potential candidate sites during MRWS Stage 4. The conclusions of this exercise will need to inform RWMD's proposals for the use of the gESC in desk-based studies.

A3-23 The gESC main report [A3.4] could usefully make reference to the 'needs' identified in RWMD's Permissions Schedule [A3.6]. The gESC refers to the Permissions Schedule only when discussing legislation other than the Environmental Permitting Regulations and guidance other than the GRA (see Section 2.5 and Appendix D Section D2 of the gESC main report).

Suitability of gESC Methodology for Different Geological Environments

A3-24 The gESC main report [A3.4], Section 2.1.1, 2nd para. (p.16) states that: "*Where appropriate to conducting the Stage 4 siting evaluations, we will apply the assessment methods used in this generic ESC to provide arguments regarding our ability to produce a safety case at the candidate site(s). Our focus will be on providing sufficient understanding of the properties of the site(s) to identify site-specific safety strategies and disposal concepts, key safety arguments, and the site-specific evidence that supports them or the type of evidence that is expected to support them.*"

A3-25 Some limitations of the scope of the work undertaken may detract from this aim. For example, the analysis of Features, Events and Processes (FEPs) and scenario development are based on the disposal of ILW within the Phased Geological Repository Concept (PGRC) [A3.7] in a higher strength rock. It is not clear from the gESC whether RWMD has reviewed the FEPs and scenarios to determine the implications of assessing the wider range of wastes, materials and geological environments.

A3-26 The suite of assessments in the gPCSA makes only a limited attempt to deal with a geological setting in a lower strength host rock and does not consider an evaporite host rock. RWMD argues that a higher strength rock provides a conservative reference case as a benchmark for packaging advice, which bounds assessments of other host geologies. Key to this argument is an assumption that there will be little available water in a lower strength or evaporite host rock. At this stage in site selection we encourage RWMD to consider more uniformly the range of geological settings in developing its assessment approach, until such time as the geological setting is defined. RMWD's post-closure safety assessments for candidate sites might need to consider different ranges of parameter values, alternative FEPs, and possibly different scenarios for future evolution of a disposal system.

A3-27 We do not consider that the descriptions of the conceptual, mathematical and numerical models are sufficiently detailed, in either the gESC main report [A3.4] or the gPCSA [A3.5], to help a technical reader develop an adequate

understanding of the system representation. They are also likely to be confusing to a non-technical reader. The detailed description of post-closure safety case methodology should be improved in future revisions of these documents. A simple description, accessible to all readers, could be included in a non-technical summary of the gPCSA.

A3-28 An improved description of the generic post-closure safety case methodology might also provide a better linkage to the proposed improvements to the LoC disposability assessment process (see paragraphs A3-9 & A3-10 above).

Use of gESC Methodology in Helping to Define Scope & Objectives of Site Investigation Work

A3-29 A particular question we have is whether and, if so, how the approach used in RWMD's illustrative quantitative assessments presented in the gPCSA will inform the siting process. We shall expect RWMD to clarify this matter in further submissions under our scrutiny programme.

R&D & the gESC

Route Towards Achieving R&D Underpinning for Site-Specific Safety Case

A3-30 No individual document within the gDSSC suite sets out the full R&D work programme. However, we are aware of other relevant documents referenced in the gDSSC (e.g. R&D Programme Overview, R&D Strategy, Steps Towards Implementation, Technical Strategy, and, in the future, Technical Plan[ii], Project Initial Documents and Work Package Definition documents) that may, together, provide a reasonable and credible route to achieving the necessary R&D underpinning. We shall pursue this further through our continuing scrutiny programme, which might include further discussion with RWMD on how best to present R&D within the framework of a DSSC.

A3-31 We have considered the R&D Programme Overview [A3.8] as part of this review.

View of R&D Presented in Status Reports & R&D Programme Overview

A3-32 The research status reports are good 'text books', i.e. repositories of information, but links from them to the needs of the ESC are not explicit. The links from the research status reports to the R&D Programme Overview [A3.8] are better, but this document also does not link back well to the ESC. We

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ii We understand that the Technical Plan will be an RWMD inward-facing document. Taken together, the RWMD Technical Strategy and Technical Plan will be equivalent to the TBuRD (Technical Baseline underpinning R&D) documents produced by Site Licence Companies created by NDA.

would expect any future site-specific ESC to integrate the evidence from R&D with claims, arguments and analysis in the ESC.

R&D Prioritisation

A3-33 Prioritising R&D is a broad and challenging task, particularly at the current stage of implementing geological disposal. It is necessarily subject to constraints, since the resources available for research are limited. We welcome RWMD's attempt to set out an approach, but we think the description in the documentation could be clearer. The challenge for RWMD will be to identify how much research effort is warranted at any given stage of implementing geological disposal to ensure appropriate coverage at that stage, while ensuring that results are available when they are needed.

A3-34 RWMD has adopted a complex approach to R&D prioritisation. We accept that a complex approach might be necessary but the discriminatory power of RWMD's current approach does not seem to warrant its complexity, given that the documentation assigns medium priority to the majority of topics and areas.

A3-35 Optimisation is potentially important in R&D prioritisation. Where a choice must be made from a range of candidate options, R&D should be considered for each candidate to ensure that enough is known about it to make and substantiate a valid choice. R&D should then be considered in pursuit of optimising the chosen option. Uncertainty about outcomes may also be important in optimisation, and hence potentially important in R&D prioritisation. If there is uncertainty about the outcome of choosing a particular option, R&D should be considered for all possible outcomes so that, even if an outcome that is assumed to be unlikely were to be realised, results are available from R&D to manage it or to show that it would have only a limited effect on environmental safety.

A3-36 In determining priorities, the types of R&D objective that need to be borne in mind include:

- The knowledge about multiple options needed to substantiate choices, whether these be different geological environments, concepts, sites or even detailed designs
- The knowledge needed about a chosen option to establish an ESC incorporating that option

A3-37 Additionally, sufficient R&D may be needed to provide a viable contingency, at the time it is required, if a chosen option cannot be taken forward at any stage. An effective, transparent system for R&D prioritisation is needed that delivers an R&D programme to meet these objectives effectively.

Accumulating & Sustaining Knowledge

A3-38 The research status reports are comprehensive when describing the historical work commissioned by RWMD and its predecessor, Nirex, but weaker on what is currently known in the context of what needs to be known (the 'knowledge gap'). We recognise that this is partly a result of uncertainty about the type of geology or geologies that may emerge as candidate sites. At this stage, and in the absence of a site, RWMD's planned R&D is focused on furthering scientific

understanding to support development of generic concepts in generic environments. It is not clear whether RWMD has applied consistent rules for assessing its knowledge gap.

A3-39 Participating in the types of international information exchange programmes referred to may certainly help RWMD maintain general awareness. However, we are concerned that, where work has been performed by others for overseas waste management agencies, RWMD may be underestimating the task of acquiring the depth of understanding needed to apply that overseas knowledge and information in a UK context. The documentation generally recognises that the relevance of such knowledge and information to the UK programme needs to be confirmed, but little evidence is provided on RWMD's capability and methods for assimilating such knowledge and information into its programme.

A3-40 For example, RWMD highlights its involvement in various European and international technical projects and programmes (such as those run by the EC, NEA and IAEA). It is not made clear whether RWMD (or Nirex, its predecessor organisation) played an active part in setting the research objectives taking into account the UK context, whether it was a funding partner without contributing research objectives, or whether it participated as an observer to maintain a watching brief. Such distinctions are too specific for the R&D Programme Overview, but are important for helping communicate what exactly was learnt so that future research is appropriately targeted and prioritised.

A3-41 Section 3.3 (p.18) of the R&D Programme Overview [A3.8], explains the phrase 'current state of knowledge' as the 'understanding within RWMD', based on work commissioned internally, by others, or by overseas organisations. The terms 'knowledge' and 'information' are then used interchangeably on p.19 to illustrate the differences between the three prioritisation categories (high, medium and low). Knowledge as understanding may be specific to an individual person at a particular time. Information can be available if it is simply stored in some accessible place, providing there is knowledge that it exists and about how to access it.

A3-42 Knowledge, in the sense of understanding, does not necessarily accumulate with time within an organisation. Where knowledge has been gained from past work, such as historical research programmes, relevant staff may have since moved on or have retired. This problem exists for all organisations but may be particularly significant for RWMD because of the large body of knowledge and information it needs to have available and the long period of time for which this will remain the case. Much UK experience relating to radioactive waste disposal resides in consultancies and universities. RWMD, when determining its knowledge gap, claims also to have addressed the available skills and capability in the supplier base, but this important aspect is not clear from the analysis. So we cannot be sure whether the R&D Programme Overview document consistently identifies key knowledge gaps in the supplier base.

A3-43 The gDSSC could usefully describe how RWMD will consider new information from R&D (both its own and other R&D nationally and internationally) and assimilate the new information into the existing body of knowledge and information relating to the environmental safety case. This needs to be a dynamic process since the ESC and the body of knowledge and information on which it is based will be progressively developed. An important consideration in assimilating new R&D results is likely to be whether they provide positive support for the existing safety arguments or whether the new results challenge the validity of these arguments, thus requiring further work and/or mitigating or compensatory measures. R&D that challenges the validity of existing

arguments needs to be discussed openly and made available for external scrutiny.

A3-44 Similarly, the gDSSC could usefully describe the process by which it (and iterations of any site-specific DSSC in the future) will be used to identify key gaps and uncertainties in safety arguments that R&D might address.

Specific Comment on R&D Programme Overview

A3-45 Section 2.2 of the R&D Programme overview [A3.8] includes (on p.8) Figure 4, a flowchart entitled Iterative development of the disposal system. This shows 'Assessments' in an iterative loop with R&D and 'Safety Cases' only as an offshoot. We consider that the safety case as a whole should be linked to R&D work, and not just 'assessments' as shown in the diagram. The safety case as a whole needs to be considered to determine what R&D might be required. R&D results might potentially affect any part of the safety case – or, indeed, the whole of it and how it is integrated.

A3-46 'Assessments' could be interpreted narrowly as just meaning numerical assessments, in which case the focus in R&D might be confined to issues related to computer modelling and parameter values. A proper focus for R&D should encompass anything with a significant bearing on the safety case, which is potentially much broader including, for example, simplified deterministic arguments and natural analogues.

Progress on Issues Highlighted in Environment Agency Review of Nirex 2005 Viability Report

A3-47 The gESC represents a significant step beyond Nirex's 2005 Viability Report [A3.3] but progress has been limited because RWMD's work is still at the generic stage.

Scope, Format & Content of gDSSC

Overall Structure

A3-48 The overall structure of the gDSSC as portrayed in the overview diagrams, such as Figure 1.2 on p.6 of the gESC main report [A3.4], is reasonable, in terms both of the general coverage of the documents and of the links shown between them. This overall structure has not been fully realised within the gDSSC in terms of the actual links between documents. This may to some extent be inevitable at the generic stage, but the links will need to be strengthened for any future site-specific ESC. Any future site-specific ESC should be coherent and largely self-contained.

Clarity of gESC Objectives as Expressed in Documentation

A3-49 The objectives and envisaged uses of the gESC are better specified than in the 2003 Generic Performance Assessment [A3.9], but there is still much room for

improvement. We would distinguish between the immediate objectives of the gESC at its date of publication in early 2011 and the envisaged uses of the suite of documents in the longer term as it is progressively updated. Although the terms 'objectives' and 'uses' are both used in the gESC main report (as also is the term 'aims', confusingly used interchangeably with 'objectives'), this distinction is not clearly made.

Success of gESC in Meeting Stated Objectives

A3-50 Certain elements of the gESC, for example the research status reports, are clearly of value in their own right. We accept that some scoping calculations are appropriate at the present stage but the future value of the quantitative assessments presented in the gESC is something that particularly requires clarification.

gESC Structure

A3-51 We find the gESC main report poorly structured and uneven in detail. It contains much repetition, both within itself and with other documents in the gDSSC. At 258 numbered pages, we think it is too long. A shorter, crisper gESC main report, providing the outline but referring out as necessary for the detail, would seem preferable and would also make it more accessible to a wider audience.

A3-52 Two examples within the gESC main report of poor structuring are:

- The length (52 pages) of the Safety Strategy section and the unevenness of detail within it. Despite its length, the strategy does not explain clearly how any future site-specific ESC will be developed and how it might assimilate material currently within the gESC; and

- The separation between where the main objectives (here called 'key aims') of the gESC are set out (in Section 1.1, pp.2-3) and where the summary responses to these main objectives are found (Section 6.2, pp.163-165).

A3-53 A limited amount of repetition within a document may be necessary to make it coherent, but too much repetition makes a document unnecessarily long and causes the reader to lose the thread. Similarly, a limited amount of repetition between documents in a suite may be necessary to bind them into a coherent whole, but too much repetition in and between documents makes consistent updating difficult. We are aware of the steps RWMD has taken to remove repetition in moving from the draft gDSSC to the published version and would encourage this to continue in future.

Success of gESC in Addressing GRA Requirements

A3-54 The GRA [A3.1] does not call for a generic ESC. We do not expect full consideration of the GRA requirements until a much later stage. The gESC addresses most GRA requirements to the extent reasonably possible at this stage.

A3-55 We consider that one area of weakness is the deferral of optimisation considerations until later. The gESC main report, Section 3.1.2.3 (p.39) [A3.4],

says: "*For the reasons noted in Section 3.1.2.1, it is premature to be considering optimisation until much later in a GDF implementation programme.*"

A3-56 We think this is wrong because:

- It is easy to postpone optimisation considerations when uncertainties are high, believing that optimisation choices will be easier when uncertainties are lower. But optimisation considerations when uncertainties are high are potentially crucial because they cause the prospective implementer to explore the range of possible ways in which things might develop and to consider what can be done to facilitate the project whatever happens. This avoids premature foreclosure of options and leads, for example, to a portfolio approach in setting R&D priorities.

- Decisions taken early on may appear at the time to have no great significance. But decisions, once taken, tend to get built upon by further decisions until a whole decision structure is created, with the early decisions forming the crucial foundations of the structure.

A3-57 We have discussed these reasons with RWMD staff and they have tended to agree with us.

A3-58 A specific example where optimisation considerations might be of value at this stage relates to the efficient use of the ILW, LLW and DNLEU (depleted, natural and low enriched uranium) vault volume. Section 3.2.1 (p.19) of the gPCSA [A3.5] states that approximately 1.2 million m3 of NRVB (Nirex reference vault backfill) would be required to close these vaults in a hard rock disposal facility. According to Table 4.1 (p.86) of the gESC [A3.4], which specifies the derived Inventory reference case considered in the gDSSC, the packaged waste volume (of ILW, LLW and DNLEU) to be accommodated in these vaults is around 461,000 m3. The ratio of NRVB required to packaged waste volume can thus be calculated as more than 2.5:1. Section 3.2.1 (p.19) of the gPCSA says that the volume of NRVB required includes the filling of the crown space in the ILW and LLW vaults. (It also puzzlingly refers to a backfill ratio of 1:1.) The quoted total amount of NRVB required seems anomalously large. If this is not an error, there seems to be scope for considering how the use of disposal vault volume might be improved.

A3-59 We would encourage RWMD in the future to place emphasis on the importance that waste owners' decisions on whether to consign wastes to a GDF or to other facilities will have in optimising a GDF and its ESC.

A3-60 It could be regarded as inconsistent that RWMD has undertaken a generic post-closure safety assessment, for example, but has chosen not to approach optimisation in any respect at the generic stage.

Assimilating Any New Statutory Requirements

A3-61 RWMD could usefully describe in the gESC how it will identify, consider and assimilate any new statutory requirements into the existing body of knowledge and information relating to the ESC as the project progresses. This might possibly be implemented through a change control procedure.

Iterative Relationship between GDF Engineered Design & Safety Requirements

A3-62 Report no. 24, Safety case management and production [A3.10], Section 2 (on p.26), states that: "*The approach to establishing the safety of a nuclear facility is to focus first and foremost on the demonstration of the robustness of the engineered design and, in particular, on its provision of defence in depth against threats to safety*". We are concerned that this suggests an approach which takes the engineered design for a new facility as a given. In our view, the engineered design should flow from the safety requirements, among other things, and should be developed iteratively. Figure 4 in Section 2.2 (on p.8) of the R&D Programme overview [A3.8] is a flowchart entitled Iterative development of the disposal system that illustrates this point (subject to the comment we have made in Paragraphs A3-45 & A3-46 on that Figure).

Evidence in gESC of RWMD's Ability to Communicate with Stakeholders

A3-63 We recognise and commend RWMD's active and visible approach to dialogue with communities and others such as pressure groups and academics at this stage and we expect this to continue and develop as implementation progresses. The Process by agreement under Requirement R1 of the GRA [A3.1] is in place and working well. We consider that the gESC adequately reflects this approach.

Whether gESC Confirms or Modifies Our 2005 Conclusion on the Viability Report

A3-64 Our 2005 conclusion [A3.2] on the Viability Report [A3.3] stated that: "*it is feasible in the medium term that a safety case could be generated that would meet regulatory requirements, provided a publicly and technically suitable site were available.*" We regard this conclusion as unchanged, providing RWMD continues to:

- Work with us to address our issues and concerns; and
- Be committed to a solution for dealing with the UK's higher activity wastes through implementation of geological disposal, supported by a safety case that is fit for purpose and demonstrates optimised environmental and safety performance in accordance with regulatory requirements.

A3-65 The gESC addresses HLW, spent fuel and separated uranium and plutonium, which were not included in the Viability Report. These additions to the inventory do not change our conclusion.

A3-66 Our comments have focused mainly on the relationship between RWMD, as the prospective licensee of any future GDF, and us as prospective environmental regulators of any GDF. We recognise how important it is for all those involved and with an interest in geological disposal (RWMD, the nuclear industry, regulators, communities and other people) to work together to address the issues and concerns that will arise in moving towards geological disposal of the UK's higher activity wastes.

Concluding Remarks

A3-67 We have reviewed those documents from the gDSSC that relate to the gESC, because it is the area where we shall have regulatory responsibility if geological disposal progresses to site-specific work. We have not attempted to comment in detail on all aspects of the gESC but we present a few detailed comments to illustrate specific points. Lack of specific comment at this stage on any particular part of the gESC should not be interpreted as providing our implicit endorsement.

A3-68 Our main guidance relevant to geological disposal, the GRA, does not envisage a generic ESC. However, we recognise that, in view of the long history and large store of knowledge and experience accumulated by RWMD, it is legitimate and potentially valuable for RWMD to publish a gESC at this stage.

A3-69 The gESC provides a good summary of the position reached to date, but it should contain additional, visible, evidence of forward thinking. We recognise that the move from a generic to a site-specific ESC is hitherto unexplored in the UK and that RWMD's views on the matter are progressively developing. The development of these views will take place to some extent as a result of discussions with others, such as regulators, communities and Government. We are reassured by the discussions we have had with RWMD that the thoughts of its staff seem to be developing along appropriate lines. We recognise that the published gESC documentation represents a snapshot in time and that RWMD's views have already developed further.

A3-70 The remarks made in paragraphs 5.2.7 to 5.2.10 of the main text of this review, concerning shortcomings in the structure of the gDSSC as a whole, apply also to the subset of documents relevant to the gESC. In particular, the links between documents are often in practice not as good as portrayed in the diagrams of the broad structure.

A3-71 Our 2005 conclusion on the Viability Report (namely that "it is feasible in the medium term that a safety case could be generated that would meet regulatory requirements, provided a publicly and technically suitable site were available") is unchanged, providing RWMD continues to:

- Work with us to address our issues and concerns; and
- Be committed to a solution for dealing with the UK's higher activity wastes through implementation of geological disposal, supported by a safety case that is fit for purpose and demonstrates optimised environmental and safety performance in accordance with regulatory requirements.

Recommendations

A3-72 The following recommendations result from EA's review of the gDSSC. They are made to help RWMD develop the gDSSC in the future and make progress towards producing an acceptable site-specific safety case for a GDF. We have numbered them sequentially following on from those in Annex 2. They are not in any order of priority.

R43. RWMD should include a clear statement about the purpose and limitations of post-closure safety assessments presented at the generic stage, in any future update of the gESC documents.

R44. RWMD should ensure that changes to the gESC, as it develops, are appropriately linked (through the LoC disposability assessment process) to advice given to waste producers and owners on waste packaging arrangements.

R45. RWMD should develop generic restrictions on chemotoxic and hazardous substances, in accordance with statutory requirements for groundwater protection.

R46. RWMD should provide a list of the generic qualitative constraints on waste packaging, together with an explanation in each case of how the constraint arises.

R47. At closure of a GDF, we would expect the ESC to be based on the inventory as disposed of. RWMD should explain how it will progress from using the published UKRWI as the basis for the ESC to using waste package information.

R48. RWMD should improve the detailed description of post-closure safety case methodology, including the description of the conceptual, mathematical and numerical models, in future revisions of the gESC and gPCSA, and consider producing simple descriptions, accessible to all readers.

R49. RWMD should clarify whether and, if so, how the approach used in its illustrative quantitative assessments will inform the siting process. We shall expect RWMD to clarify this matter in further submissions under our scrutiny programme.

R50. RWMD should clarify and map out how it might develop any future site-specific ESC. A site-specific ESC should be coherent and largely self-contained, and should integrate the evidence from R&D with claims, arguments and analysis in the ESC.

R51. RWMD needs to develop and present an effective and transparent system for prioritising R&D to ensure it delivers an R&D programme to meet the R&D objectives effectively.

R52. RWMD should describe how it will consider new information from R&D (both its own and other R&D nationally and internationally) and assimilate it into the existing body of knowledge and information relating to the ESC.

R53. RWMD should describe the process by which the gDSSC (and iterations of any site-specific DSSC in the future) will be used to identify key gaps and uncertainties in safety arguments that R&D might address.

R54. We would encourage RWMD to produce a shorter, crisper gESC main report, when it updates the gDSSC. This would make it more accessible to a wider audience.

R55. We do not agree with RWMD that "*it is premature to be considering optimisation until much later in a GDF implementation programme.*" We would encourage RWMD to consider optimisation in the early stages. This avoids premature foreclosure of options and leads, for example, to a portfolio approach in setting R&D priorities.

R56. RWMD should describe how it will identify, consider and assimilate any new statutory requirements into the existing body of information.

R57. We expect RWMD to continue with and further develop its active and visible approach to dialogue with communities and others, as implementation progresses.

Annex 3 References

A3.1 Environment Agency & Northern Ireland Environment Agency, Geological Disposal Facilities on Land for Solid Radioactive Wastes: Guidance on Requirements for Authorisation, February 2009. Available from: http://www.environment-agency.gov.uk/business/sectors/99322.aspx

A3.2 Environment Agency Report. November 2005. Review of Nirex Report: 'The Viability of a Phased Geological Repository Concept for the Long term Management of the UK's Radioactive Waste'. Version 3.1, NWAT/Nirex/05/003.

A3.3 UK Nirex Ltd, The Viability of a Phased Geological Repository Concept for the Long-term Management of the UK's Radioactive Waste, Nirex Report N/122, November 2005.

A3.4 NDA, Geological Disposal: Generic Environmental Safety Case main report, Report no. NDA/RWMD/021, December 2010. Available here: http://www.nda.gov.uk/aboutus/geological-disposal/rwmd-work/dssc/

A3.5 NDA, Geological Disposal: Generic Post-Closure Safety Assessment, Report no. NDA/RWMD/030, December 2010. Available here: http://www.nda.gov.uk/aboutus/geological-disposal/rwmd-work/dssc/

A3.6 NDA, Geological Disposal: Permissions Schedule for geological disposal of higher activity waste, NDA Technical Note No. 13395068, 2010.

A3.7 UK Nirex Ltd, The Identification and Evaluation of Issues Relevant to the Phased Geological Repository Concept (PGRC), Nirex Technical Note, 2005.

A3.8 NDA, Geological Disposal: R&D Programme overview – Research and development needs in the preparatory studies phase, Report no. NDA/RWMD/073, February 2011. Available here: http://www.nda.gov.uk/documents/upload/Geological-Disposal-Research-and-Development-Programme-Overview-February-2011.pdf

A3.9 Generic (post-closure) Performance Assessment, Nirex Report N/080, July 2003.

A3.10 NDA, Geological Disposal: Safety case production and management, Report no. NDA/RWMD/024, December 2010. Available here: http://www.nda.gov.uk/aboutus/geological-disposal/rwmd-work/dssc/

List of abbreviations

ALARP	As Low As Reasonably Practicable
BAT	Best Available Techniques
BSL	Basic Safety Level (in SAPs)
BUC	Burn Up Credit
CWS	Criticality Warning System
DCTC	Disposal Canister Transport Container
DfT	Department for Transport
DNLEU	Depleted, Natural & Low-Enriched Uranium
EA	Environment Agency
EC	European Commission
EIMT	Examination, Inspection, Maintenance and Testing
ESC	Environmental Safety Case
FEPs	Features, Events and Processes
gDSSC	generic Disposal System Safety Case
gESC	generic Environmental Safety Case
gOSC	generic Operational Safety Case
GDF	Geological Disposal Facility
GRA	The environment agencies' document Geological Disposal Facilities on Land for Solid Radioactive Wastes: Guidance on Requirements for Authorisation
HAZOP	Hazard and Operability (study)
HEPA	High Efficiency Particulate Air (filter)
HAW	Higher Activity (radioactive) Waste
HLW	High Level (radioactive) Waste
HSE	Health and Safety Executive
IAEA	International Atomic Energy Agency
ILW	Intermediate Level (radioactive) Waste
LLW	Low Level (radioactive) Waste
LoC	Letter of Compliance
MRWS	Managing Radioactive Waste Safely
NDA	Nuclear Decommissioning Authority
NEA	Nuclear Energy Agency (of the Organisation for Economic Cooperation & Development (OECD))
NRVB	Nirex Reference Vault Backfill
ONR	Office for Nuclear Regulation
OSC	Operational Safety Case

PESE	Preliminary Environmental Safety Evaluation
PDSR	Package Design Safety Report
pfd	Probability of failure on demand
RWMD	Radioactive Waste Management Directorate
SAPs	HSE's Safety Assessment Principles
SILW	Shielded ILW (package)
SWTC	Standard Waste Transfer Container
UILW	Unshielded ILW (package)
UKRWI	UK Radioactive Waste Inventory
WAC	Waste Acceptance Criteria

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