Summary Report on the Peer Review of NDA RWMD's Generic Disposal System Safety Case

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Report History

This document has been prepared by TerraSalus Limited for the Radioactive Waste Management Directorate (RWMD) of the Nuclear Decommissioning Authority (NDA), in accordance with TerraSalus document no: 2010-15-P1 and Purchase Order NPO004551, dated 9 August 2010.

Draft 1 of this report was produced and distributed to the peer review panel for review on 22 November 2010. Draft 2 incorporated revisions made in response to comments from the peer review panel on Draft 1. The report was reviewed by Adrian Bath, Peter Ball, Russell Bowden, Adrian Coyle, Ian Porter, Glyn Davies and Klaus-Jürgen Röhlig.

Version 1, dated 7 December 2010, incorporated revisions made in response to comments from the peer review panel on the topic of waste retrievability and in response to requests from RWMD on the presentation of information. The findings of the peer review panel are documented in two reports, a summary report (this report) and separate report (TerraSalus 2011, Report No: 2010-15-1B) that provides a more detailed analysis of peer review comment status and resolution. Version 1.1 represents a minor update to Version 1 with a few editorial changes made for the purposes of publication.

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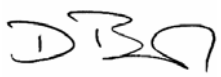
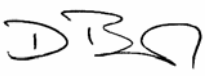
Version:	Date:	Principal Author: D G Bennett	Checked by: S E Bennett	Approved by: D G Bennett
2010-15-1A Version 1.1	12 Jan 2011	Sign  Date 12 Jan 2011	Sign  Date 12 Jan 2011	Sign  Date 12 Jan 2011

Executive Summary

The Radioactive Waste Management Directorate (RWMD) has been established as a department within the Nuclear Decommissioning Authority (NDA) to deliver geological disposal of higher activity radioactive wastes.

RWMD has developed a suite of safety case reports for a future geological disposal facility (GDF), referred to as the generic Disposal System Safety Case (DSSC). The DSSC addresses the safety of waste transport and disposal operations, as well as the safety of the GDF in the long term after the facility has been closed. Because a specific site for a GDF has not been identified, the DSSC is based on a set of assumptions regarding possible host rocks and facility designs.

In accordance with best practice in the development of such safety cases, RWMD has commissioned an external peer review of the DSSC reports. The peer review has been conducted in two phases by a multi-disciplined panel of suitably qualified and experienced reviewers. The first phase of peer review involved examination of draft versions of the DSSC reports during May and June 2010. In the first phase of its review, the peer review panel identified a large number of comments and some reservations on the draft DSSC reports and on some of the analyses they presented. A report from the first phase of peer review was completed and provided to RWMD on 1 July 2010. Following the first phase of peer review, RWMD continued to develop the DSSC documents to address comments received from the peer review panel and from various other groups and organisations. A second phase of peer review panel has been coordinated by TerraSalus Ltd. This involved reviewing later drafts of the DSSC documents, and examining the extent to which peer review comments had been addressed.

RWMD has addressed most of the key peer review comments. The presentation of the aims, objectives and achievements of the DSSC has been improved and now seems appropriate. The DSSC collates and integrates a considerable body of information from across the waste disposal programme and for a wider range of wastes and potential waste materials than has been considered previously in the UK.

The Post-Closure Safety Analysis (PCSA) demonstrates that RWMD has the capability to conduct probabilistic risk assessments relevant to the long-term safety of a GDF. The peer review panel considers, however, that further work would be needed to resolve several issues concerning the approach taken to the PCSA calculations, the inclusion and exclusion of certain processes in the PCSA models, the representation of the barriers in the disposal system, and the traceability of the data used. Given this, RWMD should not place too much emphasis on the current PCSA results when assessing waste packaging proposals.

RWMD has effectively deferred work to address some peer review comments to the forward programme. The peer review panel has provided advice on what the deferred work might need to encompass to support future versions of the DSSC.

The process of peer review followed was not ideal, but did result in improvements to the draft DSSC documents. Suggestions have been made for improvements to the peer review process.

Contents

List of Acronyms

ASA	Accident Safety Assessment
BSL	Basic Safety Limit
BNFL	British Nuclear Fuels Limited
BPEO	Best Practicable Environmental Option
BSO	Basic Safety Objective
COMAH	Control of Major Accident Hazards
CoRWM	Committee on Radioactive Waste Management
DBF	Design Basis Faults
DSSC	Disposal System Safety Case
EBS	Engineered Barrier System
ESC	Environmental Safety Case
FEP	Features, Events and Processes
GeoCAP	Geosphere Characterisation Advisory Panel
GDF	Geological Disposal Facility
GRA	Guidance on Requirements for Authorisation
HLW	High-Level Waste
HSE	Health and Safety Executive
ILW	Intermediate-Level Waste
IGSC	Integration Group on the Safety Case
IRSN	Institut de Radioprotection et de Sûreté Nucléaire
LLW	Low-Level Waste
LLWR	Low-Level Waste Repository
LoC	Letter of Compliance
MRWS	Managing Radioactive Waste Safely
NEA	Nuclear Energy Agency
NDA	Nuclear Decommissioning Authority
OECD	Organisation for Economic Development
OESA	Operational Environmental Safety Assessment
OSA	Operational Safety Assessment
OSC	Operational Safety Case
PCSA	Post-Closure Safety Assessment
PDSR	Package Design Safety Report
QA	Quality Assurance
RWMD	Radioactive Waste Management Directorate
SAP	Safety Assessment Principle
SCP&MR	Safety Case Production and Management Report
SF	Spent Fuel
THMC	Thermo-Hydro-Mechanical-Chemical
TPSA	Transport Package Safety Assessment
TSC	Transport Safety Case
TSSA	Transport System Safety Assessment

Summary Report on the Peer Review of NDA RWMD's Generic Disposal System Safety Case

1 Introduction

1.1 Background

1. The Nuclear Decommissioning Authority (NDA) has been designated by the Government as the implementing organisation for geological disposal of the United Kingdom's higher activity radioactive waste. To progress this, the Radioactive Waste Management Directorate (RWMD) has been established as a department within NDA to be the delivery organisation for geological disposal. RWMD is currently operating as a Prospective Site Licence Company under a regime of voluntary scrutiny by UK nuclear industry regulators.

2. RWMD has prepared a suite of documents which are collectively referred to as the generic Disposal System Safety Case (DSSC). The DSSC addresses the safety of transport and disposal operations, including post-closure safety, using a set of assumptions regarding possible geologies and facility designs. The DSSC documents comprise a 'Tier 0' Overview Report, three 'Tier 1' Safety Case Main Reports; the Transport Safety Case (TSC), the Operational Safety Case (OSC) and the Environmental Safety Case (ESC), several 'Tier 2' Safety Assessment Reports (Figure 1) and various Supporting Reports.

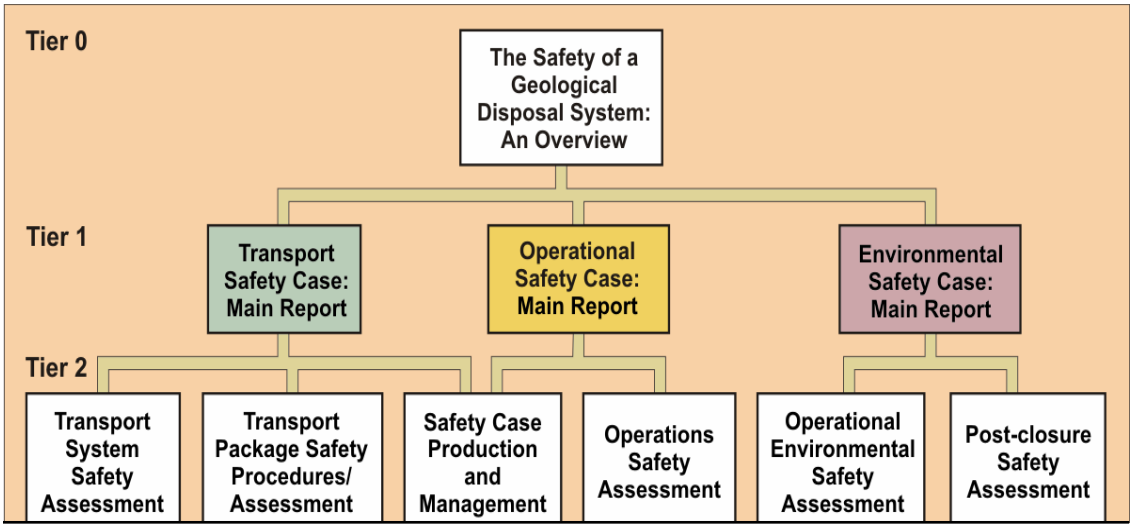


Figure 1 The upper tiers of the generic DSSC.

3. The DSSC has been produced to support the Government's Managing Radioactive Waste Safely (MRWS) process (Defra *et al.* 2008) and to provide a basis for assessments of radioactive waste packaging proposals under RWMD's Letter of Compliance (LoC) process. At this stage of the MRWS process, the DSSC has been produced on a generic basis - that is without reference to a specific site and without determining a specific type

of host rock or geologic environment for a Geological Disposal Facility (GDF). RWMD's LoC process supports the regulators' procedure for assessing and authorising the packaging of radioactive waste in advance of a final design and safety case for a future GDF. The DSSC will be updated periodically.

4. In accordance with best practice in the development of such safety cases, RWMD has commissioned an external peer review of the DSSC reports. The peer review has been conducted in two phases by members of a multi-disciplined panel of suitably qualified and experienced reviewers.

5. The first phase of peer review involved examination of draft versions of the DSSC Tier 0, 1 and 2 reports during May and June 2010. A report from the first phase of peer review was provided to RWMD on 1 July 2010 (WSC 2010).

6. Following the first phase of peer review, RWMD revised the DSSC documents to address various comments received from the peer review panel and from other groups and organisations, including the regulators.

7. A second phase of review by the peer review panel has been coordinated by TerraSalus Ltd. This involved reviewing later drafts of the DSSC documents and examining the extent to which the earlier comments from the peer review panel had been addressed. In cases where review comments were addressed by acknowledging that further work was required, this led to the identification of areas for future improvements.

1.2 Peer Review

8. Peer review may be defined as a formally documented examination of a technical programme or specific aspect of work by a suitably qualified expert or group of experts who have not been directly involved in the programme or aspect of work.

9. The environmental regulators have indicated in their Guidance on Requirements for Authorisation (GRA) (Environment Agency and Northern Ireland Environment Agency 2009) that they expect peer review to be used as one means of building confidence in the Environmental Safety Case for radioactive waste disposal facilities. The environmental regulators have stated that such peer reviews should be fully documented and provided to the relevant regulator.

10. The objective of the peer review for the DSSC was defined by RWMD as being '*to provide an authoritative, expert and independent review of the Tier 0, Tier 1 and Tier 2 Safety Assessment Reports within the DSSC'*. More detail on the approach to peer review followed is provided in Section 2.

1.3 This Report

11. This report is structured as follows:

- Section 2 describes the peer review approach that has been followed.
- Section 3 identifies the peer review panel members and demonstrates that they are suitably qualified and experienced to undertake the review.
- Section 4 summarises the peer review panel's assessments of the status of the peer review comments (for more detail see TerraSalus 2011).
- Section 5 identifies lessons learnt with respect to the process of peer review.
- Section 6 presents conclusions from the peer review.
- Section 7 provides a list of references.

2 Peer Review Approach

12. The context for the DSSC peer review was as follows:

- The peer review would be **objective** and undertaken to the highest standards of probity, based on the principles of good science and engineering.
- The review panel would be **independent** of those involved in the work of developing the reports reviewed.
- Formal methods would be used to ensure that a clear and **traceable** record was made of review comments and responses provided.

13. A peer review panel comprising the individuals and organisations shown in Table 1 was agreed with RWMD. More details of the peer review panel's qualifications and experience are provided in Section 3.

Table 1 The Peer Review Panel

Organisation	Panel Member
TerraSalus Ltd	David Bennett
ARCADIS Vectra Ltd	Brian Burke
	Peter Ball
	Russell Bowden
	Adrian Coyle
	Ian Porter
	Glyn Davies
IntelliSci Ltd	Adrian Bath
Clausthal University of Technology	Klaus-Jürgen Röhlig
Inutec Ltd	[1]Jon Jenkins
	[1]Mike Twissell
SJ Scientific Ltd	[1]Steve Jones

14. In the first phase of the peer review the aim was to provide constructive criticism such that the generic DSSC could be progressively improved. Individual reviewers were each supplied with a comments pro-forma and asked to review specific DSSC documents, focussing on their own area of technical expertise. Reviewers were asked to make clear and constructive comments and, to the extent possible, indicate what actions may be required to resolve any issues raised in their comments. Reviewers assigned their comments to one of the three following significance categories: Reservations, Observations and Minor comments.

15. The aim of the second phase of the peer review was to assess how comments from the first phase of peer review had been addressed in the revised DSSC documents. In cases where review comments were addressed by acknowledging that further work was required, this led to the identification of areas for future improvements.

[1] These reviewers contributed to the first phase of the peer review only.

16. RWMD provided the peer review panel with revised drafts of the DSSC reports in early October 2010. Table 2 identifies the reports reviewed in each phase of peer review.

17. RWMD also provided the peer review coordinator with various spreadsheets that were designed to record the DSSC report authors' acceptance or rejection of the peer review comments and their reasoning and responses to the comments. However, in practice the spreadsheets provided were not complete and did not cover all areas of the DSSC. Where they had been completed (e.g., for the ESC), the spreadsheets were provided to the relevant peer reviewers.

18. The second phase of the peer review also involved various discussions between the peer review coordinator and RWMD staff. RWMD also provided the peer review coordinator with sight of some additional documents (e.g., NDA 2010a, 2010b; in prep. (a), in prep. (b)).

Table 2 DSSC Reports Reviewed

DSSC Report	Version Reviewed in Phase 1	Version Reviewed in Phase 2
The Safety of a Geological Disposal System: An Overview	Draft April 2010	Final September 2010
Transport Safety Case (TSC): Main Report	Draft 5 28 April 2010	Draft 9 23 August 2010
Operational Safety Case (OSC): Main Report	Draft 12 30 April 2010	Draft 15 23 August 2010
Environmental Safety Case (ESC): Main Report	Version 22 28 April 2010	Version 25 30 September 2010
Transport System Safety Assessment (TSSA)	Draft 5 28 April 2010	Draft 8 4 September 2010
Transport Package Safety Assessment (TPSA)	Draft 7 28 April 2010	Draft 9 8 September 2010
Safety Case Production and Management Report (SCP&MR)	Draft 4 28 April 2010	Draft 7 3 September 2010
Operational Safety Assessment (OSA): Construction and Non-Radiological Safety	Draft 5 28 April 2010	Draft 8 6 September 2010
Operational Safety Assessment: Normal Operations Operator Dose Assessment	Draft 4 28 April 2010	Draft 6 30 September 2010
Operational Safety Assessment: Accident Safety Assessment	Draft 5 28 April 2010	Draft 9 3 September 2010
Operational Safety Assessment: Criticality Safety Assessment	Draft 4 28 April 2010	Draft 6 30 September 2010
Operational Environmental Safety Assessment (OESA)	Revision 9 28 April 2010	Not reviewed
Post-Closure Safety Assessment (PCSA)	Revision 6 28 April 2010	Draft 8 3 September 2010

3 The Peer Review Panel

19. This section provides brief curricula vitae for the peer review panel members demonstrating their qualifications and experience for conducting the review.

20. **Dr Peter Ball** has a PhD in chemistry and is a Fellow of the Safety and Reliability Society. He has over 40 years' experience in the nuclear industry, including managing a 100-strong department at Sellafield that provided the reprocessing and waste management divisions with safety assessments (covering radiological and nuclear safety), safety audits, advice on reliability data and human factors, and incident analysis and review. He has produced a number of research reports for the Nuclear Industry Methodology Committee, and has provided guidance on risk assessment for Health and Safety Executive (HSE) inspectors evaluating Control of Major Accident Hazards (COMAH) safety reports. He has also undertaken comparisons of International Atomic Energy Agency (IAEA) safety documents with HSE's Safety Assessment Principles (SAPs) for nuclear installations and their supporting Technical Assessment Guides.

21. **Dr Adrian Bath** has a PhD in isotope geochemistry and over 25 years' experience in geoscientific aspects of nuclear waste management. Over that period, he has had extensive involvement in repository siting projects and safety assessments for low-level and intermediate-level radioactive wastes, and for the disposal of spent fuel in fractured crystalline rocks and clays in several countries. His main experience and specialisation is in the interpretation of site characterisation data, in developing interpretative reports at all levels of site investigations and safety cases, and in understanding groundwater systems by integrating hydrochemical and hydrogeological information. He has been a member of RWMD's high-level Geosphere Characterisation Advisory Panel (GeoCAP) since 2008, and prior to that advised UK Nirex limited in a similar role.

22. **Dr David Bennett** has a PhD in geochemistry and water-rock interaction, and is a Fellow of the Geological Society. He has 20 years' experience in providing strategic and technical consultancy advice on radioactive waste management and its regulation. His experience includes undertaking and managing complex projects related to disposal facility authorisation / permitting, risk and safety assessment, safety cases, engineered barrier systems, waste immobilisation, geochemistry and radionuclide behaviour. He has contributed to radioactive waste management programmes in Belgium, Finland, France, Germany, Japan, Sweden, the UK and the US. He is a member of the peer review panel for the Low-Level Radioactive Waste Repository (LLWR) ESC and has also contributed to international programmes run by the European Commission, the International Atomic Energy Agency and the OECD Nuclear Energy Agency (NEA).

23. **Russell Bowden** BSc is a Chartered Physicist. He has 20 years' experience in the nuclear industry and is an expert in nuclear criticality

safety and the assessment of radiation shielding. He has significant experience in plant design and decommissioning, and his work has considered the whole of the nuclear fuel cycle. He has provided advice to the HSE Nuclear Installations Inspectorate and he has undertaken independent peer reviews of nuclear safety cases for BNFL, UK Nirex Limited and UKAEA. He is a member of the UK Working Party on Criticality and a member of OECD and IAEA technical working groups on criticality safety.

24. **Brian Burke** is a Chartered Engineer (INucE) and Technical Director of ARCADIS Vectra's Nuclear Business Unit. Since joining ARCADIS Vectra in 1986, he has made major contributions to a wide variety of nuclear safety management projects on behalf of numerous civil and defence clients. Particular areas of expertise include; project management, safety case development, radioactive waste management, nuclear safety policy and regulation. Utilising this experience, he has undertaken peer reviews and independent nuclear safety assessments of safety related documentation for a number of organisations. During this project he coordinated the activities of the ARCADIS Vectra team undertaking the review of the DSSC, but did not undertake technical reviews of the DSSC documentation.

25. **Dr Adrian Coyle** has a PhD in nuclear physics, is a Chartered Radiation Protection Professional and has 25 years' experience in the nuclear industry. He has extensive knowledge and experience of low-level and intermediate-level radioactive waste management, nuclear site regulation, and health and safety management. During his career with BNFL at Sellafield he has held senior management posts in each of these three areas. He was intimately involved in the establishment of the national regulatory forum which aims to promote effective engagement between nuclear site operators, their regulators and the NDA. For 8 years he was responsible for the operation and development of the LLWR and for the treatment and storage of plutonium contaminated materials on the Sellafield site.

26. **Glyn Davies** is a health physicist, with 16 years' experience as a Radiological Protection Advisor at Sellafield and LLWR, and 20 further years' experience as a Principal Inspector of Nuclear Installations for the HSE. While at the HSE he had lead responsibility on radioactive waste and decommissioning. He has extensive knowledge of nuclear safety case assessment, radiological protection, radioactive waste management and decommissioning on all UK nuclear licensed sites. He was a member of the UK policy group that developed Cmnd. 2919 (HMSO 1995). He also helped develop the HSE Safety Assessment Principles. He has worked closely with the Committee on Radioactive Waste Management (CoRWM). Working as an invited consultant, he has developed IAEA guidance on radioactive waste management records and led the French/Spanish/UK tripartite regulatory study into the long-term safe management of irradiated graphite waste.

27. **Jon Jenkins** BSc is a Chartered Engineer, a Member of the Institution of Chemical Engineers and a Member of the Association for Project Management. He has worked in the nuclear industry for 30 years and has taken a lead role in numerous nuclear safety assessments, peer reviewing safety assessments, developing strategies for dealing with nuclear wastes and following them up with LoC submissions. He has practical and up to date knowledge and experience of nuclear plant operations, as both an operations manager and a safety manager.

28. **Prof. Steve Jones** holds a Chair in Environmental and Occupational Toxicology at the University of Central Lancashire. He has a PhD in chemical physics and a Diploma in Company Direction. He has 35 years' experience in providing advice to the nuclear industry on a range of topics, including stakeholder dialogue, biosphere studies, radiation dosimetry, dose and risk assessment, critical groups, potentially exposed groups, radiation and chemical effects on ecosystems. He participated throughout the BNFL National Stakeholder Dialogue and was directly involved in producing consensus reports on discharges to the environment, the management of separated plutonium, and business futures. He is an invited member of the National Dose Assessment Working Group, a member of the peer review panel for the LLWR ESC, and peer reviewer for many scientific journals in the fields of radiation protection, dosimetry, radioecology and occupational medicine.

29. **Ian Porter** BA is a Chartered Engineer with 40 years' experience in the management and regulation of radioactive substances. He is a Member of the Society for Radiological Protection and has extensive experience of radioactive substances regulation at nuclear sites and in industrial, medical and academic use. During his career he has been Site Inspector at Heysham, Hartlepool, Trawsfynydd, Wylfa, Sellafield, Drigg, Springfields and Capenhurst, and he had significant involvement in the 1994 Sellafield authorisation.

30. **Prof. Dr Klaus-Jürgen Röhlig** has a PhD in mathematics and 25 years' experience in radioactive waste disposal and its regulation. He is Professor for Repository Systems at the Technical University Clausthal in Germany and Chair of the OECD Nuclear Energy Agency's Integration Group on the Safety Case (IGSC). He is also deputy chair of the German Radioactive Waste Management Commission and chairs its Committee on Final Disposal. He is also a member of the Scientific Advisory Board of the French Institut de Radioprotection et de Sûreté Nucléaire (IRSN). He has participated in several international peer reviews of safety reports for geological disposal facilities produced in France and in Sweden. His work has included the development of safety case methodologies, the establishment of safety criteria, numerical modelling of fluid flow and contaminant migration in repository systems, and the application of probabilistic and geostatistical methods in the safety case. He has extensive knowledge of plans for the disposal of radioactive wastes in evaporite host rocks.

31. **Mike Twissell** BSc is a Chartered Chemist, a Member of the Royal Society of Chemistry and a Member of the Association for Project Management. He has over 20 years of experience in the nuclear industry. He is a specialist in the field of radioactive waste management and process development. He has managed high-level Best Practicable Environmental Option (BPEO) studies, including stakeholder engagement with members of the public and regulators. He has published many technical reports and publications on various aspects of radioactive waste management for a variety of UK and overseas customers.

4 Summary of the Status of Peer Review Issues

32. Tables 3, 4 and 5 identify the main areas of the TSC, OSC and ESC in which the peer review panel made comments, and summarise the status of issues in these areas. More details of the peer review panel's comments and assessments of the status and resolution of the peer review comments are provided in TerraSalus (2011).

33. In Tables 3, 4 and 5, the text in the 'Status' column records first whether RWMD accepted or rejected the peer review panel's original comments, second whether the draft DSSC documents were modified in response to the peer review panel's comments, and third whether the peer review panel considers the issue to be (i) resolved, (ii) unresolved and requiring further work, or (iii) unresolved, but not significant.

Table 3 Status of issues for peer review comments on the TSC.

No.	Peer Review Comment Area	Status
1	**Transport Safety Case**	
1.1	Distinguishing clearly between doses and risks	Peer review comments accepted by RWMD, and issues addressed, but the peer review panel considers that further work would be required to assess the potential risks associated with faults and accidents in the waste transport system.
1.2	Assessing accident risks and doses to the public	Peer review comments mostly rejected by RWMD. Issues partly addressed, but the peer review panel considers that further work would be required to assess potential doses to workers from accidents, and potential doses to the public from routine operations and accidents.
1.3	Approach for considering chemotoxic waste components	Peer review comments accepted by RWMD, and issues addressed and resolved.
1.4	Details of the TSC assessment calculations	Peer review comments accepted by RWMD, and issues addressed and resolved.

Table 4 Status of issues for peer review comments on the OSC.

No.	Peer Review Comment Area	Status
2	**Operational Safety Case**	
2.1	Planning for GDF facility decommissioning	Peer review comments accepted by RWMD, and issues addressed and resolved.
2.2	Waste retrievability	Peer review comments partly addressed by RWMD, but issues not resolved. The peer review panel considers that further work is needed to clarify how a GDF would be licenced to meet the requirements of Government policy on MRWS and to clarify the effect of the Nuclear Site Licence and associated regulatory requirements on provisions for waste retrievability.
2.3	Treatment of active and passive engineered features	Peer review comments accepted by RWMD, and issues addressed and resolved.
2.4	Comprehensiveness of operational dose assessments	
2.4.1	Assessment of routine doses to workers	Peer review comments accepted by RWMD, and issues addressed and resolved.
2.4.2	Accident safety assessment	Peer review comments accepted by RWMD, and issues addressed, but the peer review panel considers that more detail may need to be provided to demonstrate compliance with HSE SAPs.
2.5	Considering the potential impacts of naturally-occurring radon	Peer review comments accepted by RWMD and issues addressed, but the peer review panel consider that further work would be required to assess the impact of radon from the host rocks on ventilation, GDF operations, and worker doses.
2.6	Clarity and justification of the Letter of Compliance process	Peer review comments accepted by RWMD and issues addressed, but the peer review panel considers that further information is required to document the Letter of Compliance (LoC) process in detail within the DSSC, to justify the approaches being followed and, in particular, to explain and justify how calculation results from the Post-Closure Safety Assessment (PCSA) are, or may be, used to inform the LoC process in a quantitative sense, taking account of uncertainties in disposal system performance.

Table 5 Status of issues for peer review comments on the ESC.

No.	Peer Review Comment Area	Status
3	**The Environmental Safety Case**	
3.1	Objectives and achievements of the DSSC, ESC and PCSA	Peer review comments mostly accepted by RWMD, and issues addressed and resolved.
3.2	Quality assurance and management controls	Peer review comments accepted by RWMD, and issues addressed and resolved.
3.3	Providing evidence to support safety arguments	Peer review comments accepted by RWMD, and issues addressed, but the peer review panel considers that further work would be required to include more evidence in the safety case reports to support the safety arguments.
3.4	DSSC update schedule and disposal concept selection	Peer review comments partly accepted by RWMD, and issues addressed, but the peer review panel considers that it would be sensible to provide further information on RWMD's plans for the disposal programme within the DSSC.
3.5	Optimisation	Peer review comments partly accepted by RWMD, and issues addressed, but the peer review panel considers that further dialogue may be necessary to clarify what is required within the DSSC to demonstrate optimisation.
3.6	PCSA calculations	Peer review comments mostly accepted by RWMD and issues addressed to an extent, but the peer review panel considers that further work would be needed to resolve several issues concerning the approach taken to the PCSA calculations, the inclusion and exclusion of certain processes in the PCSA models, the representation of the barriers in the disposal system, the traceability of data used, and the presentation and use of PCSA results.
3.7	Model validation	Peer review comments rejected by RWMD. Issues not resolved, but the peer review panel considers that this is not significant – see TerraSalus (2011).
3.8	Treatment and management of uncertainty	Peer review comments accepted by RWMD, but no changes made to DSSC reports. Issues not resolved, but the peer review panel considers that this is not significant – see TerraSalus (2011).
3.9	Forward programme	Peer review comments mostly accepted by RWMD, and issues addressed and resolved.
3.10	Register of uncertainties	Peer review comments accepted by RWMD, and issues addressed, but the peer review panel considers that further work would be required to develop a detailed register of uncertainties that can serve as a useful tool for uncertainty management.

5 The Peer Review Process – Lessons Learnt

34. Peer review should be an on-going and interactive process that continues throughout the programme of safety case and GDF development – a process that may well last several tens of years. In contrast, this peer review project was organised as a sequence of brief, 'task and finish' projects, and the original schedule specified for the review was so short that it affected the quality of the dialogue between the peer review panel and the safety case development team.

35. Peer review should also be a routine part of the work process and enough time should be set aside both for the review and for the safety case development team to be able to engage thoughtfully with the substance of the peer review comments and respond appropriately. The peer review conducted during this project was not allocated sufficient time to check key information in supporting documents.

36. The peer review was initiated too late in the DSSC development process. This is illustrated by the fact that the first drafts/versions of the OSC and ESC reports seen by the peer review panel were already at versions 12 and 22 (Table 2). As a result, RWMD had already made significant decisions on the approaches to be followed (e.g., the approach to, and scope of, safety assessment calculations) and it was, therefore, difficult for the safety case development team to respond in a substantive way to peer review comments that questioned the scope of the work or the approaches taken. Evidence for this latter point was provided during discussions with RWMD staff and in the form of acknowledgements in the text of the revised DSSC reports of the limitations of the analyses presented and the identification of areas where further work might be needed.

37. Although RWMD implemented a process for attending to peer review comments that involved the use of spreadsheets, the process did not provide the peer review panel with a complete or traceable record of how each peer review comment had been considered, or identify where in the DSSC documentation revisions had been made to address peer review comments. This lack of a complete audit trail made the conduct of the second phase of peer review more difficult and less efficient. The difficulties encountered included peer reviewers having to search through large volumes of reports to assess whether and how peer review comments had been addressed. This was particularly difficult when a peer review comment had been addressed by the deletion of text and / or where additions and re-ordering of text significantly altered the numbering of sections.

38. The process for attending to peer review comments does not seem to have been fully implemented across the whole of the DSSC. Where the process was implemented it was not used consistently and, in a few cases, inappropriate responses to peer review comments were provided. As an example of inconsistency, peer review comments on the PCSA were often

accepted, but essentially identical comments were often rejected when addressed to the ESC main report.

39. The process for attending to peer review comments needs to be capable of dealing with peer review comments that may affect the approaches being taken, or that may affect several reports within in the safety case. In some instances individual recipients of valid peer review comments seemed unable to address the comments properly because the comments had implications for several safety case documents. There was, therefore, sometimes the sense that responses to peer review comments came from individuals rather than from RWMD as an organisation.

40. RWMD's process for reviewing the draft DSSC reports as they were developed was rather complex and it would seem appropriate to look for ways in which the process could be simplified and improved. Part of the complexity related to the involvement of so many different review groups in the process. In addition to the peer review panel, RWMD commissioned a separate team of consultants to review the supporting documents, and involved various internal advisory panels and the Nuclear Safety and Environment Committee. It would be sensible to consider the necessity for all these groups, their roles in the process, the relationships between them, and the relative timing of their work. The scheme arrived at from such considerations should be documented and communicated to those involved.

41. The peer review process was also made more difficult as a result of there not being sufficient referencing to information within RWMD's programme, but considered by RWMD to be outside the DSSC (e.g., NDA 2010a; NDA 2010b; NDA in prep. (a)). It is suggested that RWMD could usefully take a broader view of the safety case and make more use of the safety case as a tool for integrating its work and planning across the entire the disposal programme.

6 Conclusions

42. RWMD has conducted a considerable programme of work to develop a generic disposal system safety case for a geological disposal facility. As part of its programme, RWMD commissioned an external peer review of the DSSC reports.

43. The DSSC has collated and integrated a considerable body of information from across the waste disposal programme and for a wider range of wastes and potential waste materials than has been considered previously in the UK. The peer review panel considers that this collation and integration of information is an important and not insubstantial achievement.

44. In the first phase of its review, the peer review panel identified a large number (~700) of comments and some reservations on the draft DSSC reports and on some of the analyses they presented. The most significant peer review comments related to the DSSC in general, to the Environmental Safety Case, to the Post-Closure Safety Assessment, and to the Letter of Compliance process (WSC 2010).

45. Most of the key peer review comments have been addressed.

46. The presentation of the aims, objectives and achievements of the DSSC has been improved and now seems appropriate.

47. The PCSA has demonstrated that RWMD has the capability to conduct probabilistic risk assessments relevant to the long-term safety of a geological disposal facility. The peer review panel considers, however, that further work would be needed to resolve several issues concerning the approach taken to the PCSA calculations, the inclusion and exclusion of certain processes in the PCSA models, the representation of the barriers in the disposal system, the traceability of the data used (see TerraSalus 2011). Given this, RWMD should not place too much emphasis on the current PCSA results when assessing waste packaging proposals.

48. RWMD has effectively deferred work to address some peer review comments to the forward programme. The peer review panel has provided advice on what the deferred work might need to encompass to support future versions of the DSSC.

49. The process of peer review followed was not ideal, but did result in improvements to the draft DSSC documents. Suggestions have been made for improvements to the peer review process that could be considered for the development of future versions of the DSSC.

7 References

1. Defra, BERR and the devolved administrations for Wales and Northern Ireland (2008) Managing Radioactive Waste Safely: A Framework for Implementing Geological Disposal. Cmnd 7386.

2. DECC (2010) Revised Draft National Policy Statement for Nuclear Power Generation (EN-6) Volume II of II – Annexes. Department of Energy and Climate Change (DECC), ISBN: 9780108509391.

3. Environment Agency and Northern Ireland Environment Agency (2009) Geological Disposal Facilities on Land for Solid Radioactive Wastes: Guidance on Requirement for Authorisation. February 2009.

4. Environment Agency (2010a) Environment Agency Scrutiny of NDA RWMD's Work Relating to Geological Disposal of Higher-Activity Solid Radioactive Waste: Annual Review 2009/10, Version 1.0. Environment Agency Product Code GENW1010BTEC-E-E.

5. Environment Agency (2010b) Understanding Controls on the Performance of Engineered Barrier Systems in Repositories for High-Level Radioactive Waste and Spent Fuel. Environment Agency Report: SC060055.

6. HMSO (1995) Review of Radioactive Waste Management Policy: Final Conclusions, Cmnd 2919.

7. HSE (2009) Proposals to Alter Some Aspects of the Existing Arrangements for Licensing of the Storage and Disposal of Radioactive Wastes. Summary Document. HSE Nuclear Directorate, ND 1726.

8. NDA (2010a) Geological Disposal: Steps Towards Implementation. NDA Report No. NDA/RWMD/011c, Issue 1.

9. NDA (2010b) Geological Disposal: Radioactive Wastes and Assessment of the Disposability of Waste Packages, NDA Report NDA/RWMD/039, Revision 'Final V1', 12 November 2010.

10. NDA (in prep. a) Geological Disposal: Permissions Schedule for Geological Disposal of Higher Activity Radioactive Waste. Document No 13347929, Revision 5.

11. NDA (in prep. b) Geological Disposal: Generic Design, NDA Report NDA/RWMD/048, Revision V02.

12. SKB (2006) Long-Term Safety for KBS-3 Repositories at Forsmark and Laxemar – A First Evaluation: Main Report of the SR-Can Project. Svensk Kärnbränslehantering AB. Technical Report TR-06-09. 620pp.

13. TerraSalus (2011) Peer Review of NDA RWMD's Generic Disposal System Safety Case, Analysis of Peer Review Comment Resolution, TerraSalus Report No: 2010-15-1B, Version 1.1.

14. WSC (2010) External Technical Peer Review of NDA RWMD's Generic Disposal System Safety Case Tier 0, 1 and 2 Safety Documents. Westlakes Scientific Consulting Ltd. Document Number: 090252/03.