

LLWR Environmental Safety Case

Response to the International Peer Review of the Approach and Preparations for the Environmental Safety Case Project

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Response to the International Peer Review of the Approach and Preparations for the Environmental Safety Case project

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Executive Summary

The Low Level Waste Repository (LLWR) is the UK's principal facility for the disposal of solid low-level radioactive waste (LLW). Disposals of radioactive waste to the LLWR are regulated by the Environment Agency.

The LLWR is committed to a process of peer review as part of the process of building a robust 2011 Environmental Safety Case (ESC). As part of this process, LLWR commissioned a review by an international team of peers with experience from other radioactive waste disposal facilities – the International Peer Review Group (IPRG). The aim is to provide insights and perspectives from experts operating other disposal facilities, which would help the LLWR ESC team address issues that are being confronted in developing the 2011 ESC. The International Peer Review Group consisted of safety assessment professionals associated with the SFR facility in Sweden, the Centre de l'Aube facility in France and the El Cabril facility in Spain. The organisations involved were SKB of Sweden, Andra of France and Inutec – a Westinghouse Company – from Spain.

We recognise that the IPRG undertook their review at a time when the structure and approach for the 2011 ESC were still being finalised. As a consequence, the IPRG review does not fully recognise LLWR's planning at the time of the review. Many of the issues raised by IPRG in their recommendations had already been identified by LLWR. Notwithstanding this, we have found the review process valuable, and have ensured that, where appropriate, the key issues raised by IPRG are addressed in the 2011 ESC.

Our response to the IPRG review was prepared in April 2011, when the 2011 ESC documentation was essentially complete. In this review, we identify which ESC report or reports address the issues raised by IPRG, and give a brief summary of the approach that we have adopted.

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1 INTRODUCTION

The Low Level Waste Repository (LLWR) is the UK's principal facility for the disposal of solid low-level radioactive waste (LLW). The site is owned by the Nuclear Decommissioning Authority (NDA) and operated on behalf of the NDA by a Site Licence Company (SLC), owned by United Kingdom Nuclear Waste Management (UKNWM) Ltd.

The LLWR is committed to a process of peer review as part of the process of building a robust safety case. As part of this process, LLWR commissioned a review by an international team of peers with experience from other radioactive waste disposal facilities – the International Peer Review Group (IPRG). The IPRG consisted of safety assessment professionals associated with the SFR facility in Sweden, the Centre de l'Aube facility in France and the El Cabril facility in Spain. The organisations involved were SKB of Sweden, Andra of France and Initec – a Westinghouse Company – from Spain.

The IPRG's review focussed on issues that were:

- important to the development and evaluation of options that may be available to promote the safe and efficient use of the LLWR;
- important to the assessment of impacts associated with the LLWR, its operations and post-closure performance;
- important to the clear presentation of evidence and arguments that must be achieved within the ESC.

The IPRG was supplied with copies of the following documents:

- *Technical Approach to the 2011 ESC* [1].
- LLWR Submission against Schedule 9 Requirement 2:
 - Volume 1 – *Managing existing liabilities and future disposal at the LLWR* [2].
 - Volume 2 – *Assessment of options for reducing future impacts from the LLWR* [3].
 - Volume 3 – *Inventory and near field* [4].
 - Volume 4 – *Site understanding* [5].
 - Volume 5 – *Performance update for the LLWR* [6].
- Environment Agency Review of LLW Repository Ltd's Requirement 2 submission, draft for information, 3rd March 2009:
 - Volume 1 – *Overview* [7].

Volume 2 – *Assessment of Options for Reducing Future Impacts from the LLWR* [8].

Volume 3 – Inventory and near field [9].

Volume 4 – Site Understanding [10].

Volume 5 – Performance Update for the LLWR [11].

- Peer Review of Requirement 2 Submission [12].
- LLWR ESC Response to the Peer Review Comments on Requirement 2 [13].
- Review Summary of 2002 Safety Case Overview Report [14].
- Project Execution Plan LLWR/ESC/PM(08)001 [15].
- LLWR ESC: 2009 Risk Register [16].
- ESC Project Memo: Assessment of Human Intrusion in the 2011 ESC [17].
- LLWR Memo LLWR/ESC/MeM(09)035, Hydrogeological Models Engineering Performance Elicitation Workshop, August 2009 [18].

The IPRG used the information within these documents to gain an understanding of the LLWR and the issues and approaches facing the ESC team. In addition, a number of issues were raised and discussed during meetings and dialogue between the IPRG and the LLWR ESC team. The review was conducted over the period June 2009 to February 2010 and involved two meetings with the LLWR ESC team. A draft of the IPRG's report was provided to the LLWR in November 2009. The LLWR's team commented on the draft report, and a final version of the report was subsequently issued in April 2010.

The objective of this document is to indicate how the LLWR has addressed the IPRG's findings. A commentary and response to the IPRG's detailed findings are set out in section 2. Key issues and conclusions are summarised in section 3.

2 RESPONSE

This section contains a response to each of the IPRG's recommendations. We have numbered recommendations to correspond to the subsections in the IPRG's report.

We recognise that the IPRG undertook their review at a time when the structure and approach for the 2011 ESC were still being finalised. As a consequence, the IPRG review does not fully recognise LLWR's planning at the time of the review. Many of the issues raised by IPRG in their recommendations had already been identified by LLWR. Notwithstanding this, we have found the review process valuable, and have ensured that, where appropriate, the key issues raised by IPRG are addressed in the 2011 ESC.

Our response to the IPRG review was prepared in April 2011, when the 2011 ESC documentation was essentially complete. In this review, we identify which ESC report or reports address the issues raised by IPRG, and give a brief summary of the approach that we have adopted.

2.1 *Environmental Safety Case – General Issues*

IPRG recommendation (S2.3) That the LLWR team has a strong dialogue with regulators and other stakeholders to level the expectation of the final product. This could take the form of continued regular dialogue with regulators, meetings, workshops to address specific topics etc.

LLWR approach

We have and continue to place a strong emphasis on dialogue with regulators and other stakeholders. Key aspects are summarised below:

- A project-specific stakeholder plan is described in our '*Management and Dialogue*' report.
- We hold regular meetings with the Environment Agency (EA). Monthly liaison meetings are held, to which the Office of Nuclear Regulation (ONR) and the Nuclear Decommissioning Authority (NDA) are invited. The agenda for each meeting includes: progress with ESC programme, nine-week lookahead, financials, monitoring update, updates from other organisations and technical presentations. Presentations have been made upon many key issues within the ESC such as human intrusion and coastal erosion.
- There is a site stakeholder group, at which LLWR presents regular updates on the ESC. Specifically for design optimisation, a meeting was held with local authorities, the EA and the NDA to discuss LLWR's proposed approach.

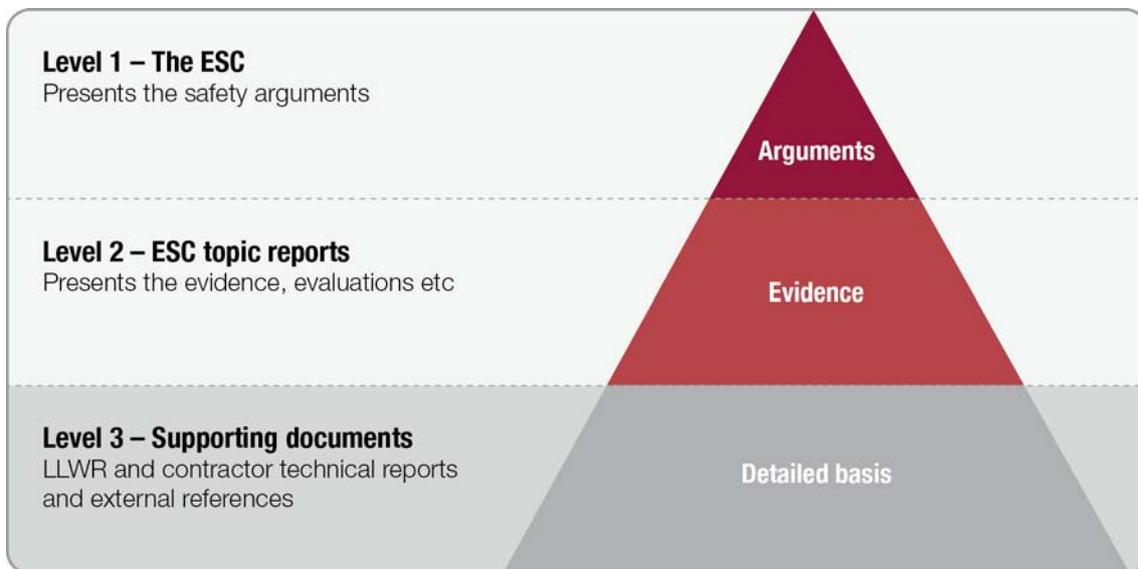
IPRG recommendation (S2.6) A key recommendation from the IPRG is that more consideration should be given to the presentation of the ESC in terms of giving a clear picture or 'story' regarding the site and the authorisation that is being sought from the regulators. This is an observation that is further developed during the later sections of this review report. A key

part will be the arguments dealing with scenarios to be taken into account in the safety assessments. The uncertainty management and a clear argument explaining why the coastal erosion may be considered as an alternative scenario could be presented.

LLWR approach

A clear presentation of the 2011 ESC to a range of stakeholders is a key objective of LLWR. We have achieved this through the following.

- We have developed a documentation concept for the 2011 as shown below. It consists of three levels of reports:
 - the Level 1 '*Main Report*' for the 2011, which outlines the main arguments concerning environmental safety and how this is provided.
 - A series of 'Level 2' reports, which present the evidence that underpins our safety arguments, including descriptions of our management framework, system understanding, design and management choices and assessments;
 - The ESC is supported by a large number of technical and scientific reports and references, which we refer to as 'Level 3' documents.
 - Level 1 and 2 reports are shown in the following table.



The ESC documentation concept

- Scenarios are described at a high-level in our '*Main Report*' and in more detail in the underlying reports.
- We have also produced a Non-technical Summary of the ESC, to help a wider group of stakeholders understand its nature, conclusions and implications.

The application for an authorisation (now Permit) will be made subsequent to the submission of the ESC.

Regarding coastal erosion, we wish to emphasise that we see coastal erosion as the expected outcome. It therefore forms part of our reference scenario for the expected natural evolution of the site. See also our response to IPRG recommendation (S7.6).

In conclusion, we have addressed the issue raised by the IPRG.

Table 1.1: The 2011 ESC reports	
Level 1	
The 2011 Environmental Safety Case – Main Report [19]	
Level 2	
Management and dialogue	Management and Dialogue [20]
System characterisation and understanding	Site History and Description [21] Inventory [22] Engineering Design [23] Near Field [24] Hydrogeology [25] Site Evolution [26] Monitoring [27]
Optimisation and Site Development Plan	Optimisation and Development Plan [28]
Assessments	Environmental Safety During the Period of Authorisation [29] Assessment of Long-term Radiological Impacts [30] Assessment of Non-radiological Impacts [31] Assessment of impacts on Non-human Biota [32] Waste Acceptance [33] Assessment of an Extended Repository [34]
Audit	Addressing the GRA [35]

2.2 Optimisation

IPRG recommendation (S3) If acceptable from the regulators' point of view it may be a good idea to exclude the discussion on design options from the ESC. Design options could then be treated in a separate study, where also other issues than radiological risk are studied. From a regulators' perspective this would help to clarify the point of what exactly the regulators are

being asked to authorise and give an opportunity to discuss the regulators expectations regarding optimisation.

LLWR approach

Demonstration of optimisation is a specific radiological requirement for authorisation in the relevant regulatory guidance. We have therefore not accepted the IPRG recommendation. We have, however, structured our safety arguments to distinguish the optimisation process leading to our Site Development Plan (described in our '*Optimisation and Development Plan*' report) from the engineered system assessed (described in our '*Engineering Design*' report).

2.3 Inventory

IPRG recommendation (S4/1) If the primary target is to seek authorisation for the existing facilities, a safety case based on existing waste disposed of in vault 8 and estimations for the next vault 9 could be an option. Estimations for future vaults (excl vault 9) should be considered as variations of this case. Estimations of waste already disposed of, and steps to improve data on waste in the trenches 1-7, should be described in the ESC.

LLWR approach

A key objective of the 2011 ESC is to demonstrate optimisation of the LLWR as a whole and to identify the operational lifetime of the facility. Understanding the lifetime of the facility is an important input to national waste management strategy. Hence, we address both existing and future disposals in our ESC. Based on this approach, we identify a number of inventory cases to take account of uncertainties in future arisings.

We have therefore not accepted the IPRG recommendation.

IPRG recommendation (S4/2) The use of actual data as far as possible (actual data should override the data from the national inventory) should be a basic principle for estimating contents of radionuclides and materials in the waste. It is commendable that the LLWR team have been able to establish that the radionuclide content of vault 8 is possibly reduced by half just by applying actual data. The vault has been in use since 1988 and a significant part of it should have been filled by 2002. It seems that the estimation made 2002 did not take the actual inventory into consideration.

LLWR approach

Our approach to determining inventories for the 2011 ESC uses both 'actual data' and data on future wastes from the UK Radioactive Waste Inventory (UKRWI). In particular:

- We use a mixture of actual data and UKRWI data to estimate the disposed inventory in the trenches. Our approach is discussed and justified in our '*Inventory*' report and supporting Level 3 reports.
- For future arisings, we have used the UKRWI coupled with information from other sources (WIDRAM09) to estimate inventory. Again, our approach is discussed and justified in our '*Inventory*' report and supporting Level 3 reports. As part of this programme, we have also reviewed information on key waste streams.

- For the specific issue of Vault 8 raised by IPRG, we do not recognise the factor of two reduction from applying 'actual data'. Our approach to deriving an inventory for waste disposed to Vault 8 up to 2008 primarily used information from the Repository's Low Level Waste Tracking System (LLWTS) on an individual consignment basis, supplemented by radionuclide fingerprint information from the 2007 UKRWI where necessary.

IPRG recommendation (S4/3) To get a better understanding and quantification of data for the trenches use of existing documents is a good start (as it is done in the new update). Back fitting of data from vault 8 as it was done in the 2002 update seems not to be reliable because of e.g. the large heterogeneity in the waste. To reduce the uncertainties in the content of the trenches a good approach is to go back to the waste producers and see if there is any information available that is not already documented at the repository site. The information can be written documents or knowledge of employees at the waste producers' sites.

LLWR response

Since the 2002 safety cases, substantial work has been undertaken to develop an improved inventory of radioactivity in the trenches, Vault 8 and future vaults. The work has focused on understanding the most important disposals and in particular on quantifying the key uncertainties. This work is summarised in our '*Inventory*' report and in a supporting Level 3 report.

For example, we have undertaken interviews with individuals with previous operational and other relevant experience to elicit information on disposal practices and determine any impact on estimates of the disposed inventory.

In conclusion, we have addressed the issue raised by IPRG.

IPRG recommendation (S4/4) LLWR are encouraged to continue the efforts put into the understanding of historical waste in the trenches as this seems to give good results in reducing uncertainties and to better understand the inventory as a whole.

LLWR response

Noted. We have addressed the issue raised by IPRG. For example, see our responses above and our '*Inventory*' report and supporting Level 3 reports.

2.4 Near field

IPRG recommendation (S5/1) The IPRG encourages the LLWR ESC team to make a description of the expectations of the different barriers in the near field. An example could be that the cut-off walls will (or are expected to?) limit the ground water flow through the trenches, which is achieved by their low hydraulic conductivity. At this stage it would be sufficient to describe the beneficial properties of the barriers without quantification, since it may be difficult or unnecessary to give quantitative expectations at this stage. This will aid in the description of the barrier evolution.

LLWR approach

Our '*Near Field*' report discusses the physical and chemical evolution of the near field in detail. We have also undertaken elicitations to determine parameter values for key safety-relevant processes such as metal corrosion. Quantification of processes has been undertaken because these are required inputs for performance assessment.

The design functions of the different engineered barriers in the near field are discussed in the:

- '*Main Report*';
- '*Optimisation*' and '*Engineering Design*' reports;
- Level 3 design optimisation reports.

We also present Level 3 hydrogeological modelling reports that describe (i) the optimisation of engineered barriers from the context of flows and water levels in the repository and (ii) the evolution of water levels and flows in the repository in response to degradation of the engineered barriers and expected natural evolution (sea level rise and coastal erosion).

In conclusion, we have addressed the issue raised by IPRG.

IPRG recommendation (S5/2) The initial state of the near field should be clearly defined and described. This should include materials and dimensions as well as the associated uncertainties such as failed construction, stray materials, etc. It could also be worthwhile to document the properties assigned to the different materials, both maximum and minimum values. This will aid the quality assurance, since it makes sure that everyone uses the same data.

LLWR approach

Our '*Near Field*' report discusses the initial state of the near field and its expected physical and chemical evolution. The '*Engineering Design*' report describes the engineering barriers (including closure engineering) and their purposes. Our '*Inventory*' report describes the waste materials. We clearly define the initial state of the near field in the following:

- material inventories have been calculated for the various inventory cases. These identify some 60 different material categories (e.g. graphite, soil, stainless steel) and give the volume of each category for different Inventory Cases;
- properties of the near field (e.g. corrosion and degradation rates, solubilities, sorption coefficients) have been derived from literature review or expert elicitation. Parameter values are clearly defined in assessment and process modelling reports;
- the impacts of parameter uncertainty have been addressed through probabilistic calculations for groundwater pathway, and by sensitivity calculations for the gas and groundwater pathways. We discuss this further in our '*Assessment of Long Term Radiological Impacts*' report;

- uncertainties in near-field evolution has been addressed by use of two near-field models, one of which addresses kinetic release of contaminants from metal and graphite wastefoms;
- the effect of heterogeneity in waste composition and inventory is addressed in the model (GRM) that we use to describe near-field evolution (e.g. release of C-14 from waste).

In conclusion, we have addressed the issue raised by IPRG.

IPRG recommendation (S5/3) The IPRG suggests a focus on the description of the evolution, not on the calculations and properties of the barriers. This is a further development of the earlier observation in Chapter 2 regarding the presentation of the ESC.

LLWR approach

It is clearly important that we can demonstrate an understanding of the system and its future behaviour, and can build confidence in and communicate this understanding. Within the ESC, it is also necessary to calculate the performance of the system as it evolves. For the 2011 ESC, we therefore present both a clear description of the evolution of the near field and calculations of safety-relevant measures (e.g. aqueous and gaseous fluxes of C-14 in the near field, radionuclide concentrations in near-field porewater).

IPRG recommendation (S5/4) Even more emphasis could be put on the monitored data from the site. Data and observations could be collected in a separate report/section and these could then be used to confirm modelling results. The importance of this for confidence building cannot be underestimated.

LLWR approach

LLWR recognises the importance of site characterisation and environmental monitoring. Data from both these programmes are used in support of the 2011 ESC in the manner recommended by IPRG:

- site characterisation data and environmental monitoring data are reported in separate Level 2 reports, as suggested by IPRG. A specific section of the '*Monitoring*' report addresses the use of monitoring data in ESC;
- site characterisation data have been used to develop the conceptual geological and hydrogeological site models and to calibrate and build confidence in these models. For example, groundwater levels, leachate and stream flows and tritium activities in groundwater have all been used to calibrate the hydrogeological model used in the 2011 ESC;
- current environmental monitoring data have been used to estimate environmental safety at later times in the Period of Authorisation.

In conclusion, we have addressed the issue raised by IPRG.

2.5 *Geology and Site*

No IPRG recommendations made.

2.6 *Assessments*

IPRG recommendation (S7.3) A safety function methodology may very well be used for the LLWR. The key benefits would be:

- that the description of the repository evolution can be focussed on the issues that are important for the performance
- scenarios can be selected in a systematic/structured way. Most likely the same scenarios will be identified, but the selection process will be transparent

LLWR approach

We are familiar with the safety function methodology, and indeed use the language and methodology of 'safety functions' in our '*Main Report*' and '*Optimisation*' report. However, we have not chosen to give that approach as much emphasis as is the case in some other waste management programmes.

More importantly, and as our document hierarchy demonstrates, our approach to the safety case has been to identify important safety-relevant features, events and processes in the system. These are discussed in the '*Main Report*', safety arguments are made and scenarios developed. A FEP database has been produced, against which our scenarios can be referenced. The FEP database also includes a register of uncertainties, which indicates how uncertainties have been addressed. This fulfils the regulatory requirement to address uncertainty management.

In conclusion, we have addressed the issue raised by IPRG.

IPRG recommendation (S7.6) The coastal erosion scenario could be considered as part of the normal reference groundwater scenario but this is a matter for the LLWR team to decide. However it is the IPRG view that under all circumstances the 'no coastal erosion' scenario should be part of the considerations of the evolution over extended timescales.

LLWR approach

We wish to emphasise that we expect sea level rise and coastal erosion to occur leading to the erosion of the repository at some time in the future. Coastal erosion and sea level rise therefore form part of our expected natural evolution scenario, which is the reference case for the 2011 ESC.

We do include an alternative scenario, the Delayed Coastal Erosion scenario, in which no coastal erosion or sea level rise occurs. We do not, however, expect this behaviour. We present the scenario as a 'what if' case to bound uncertainties in the natural evolution of the system.

In conclusion, we include a 'no coastal erosion' scenario as recommended by the IPRG, but wish to emphasise this is not our reference case.

IPRG recommendation (S7.8) Agree with the EA the conditions for the human activities in the beach that require evaluation in the CE scenarios and give further consideration to the presentation of controversial scientific issues to stakeholders as part of the effective communication of the ESC.

LLWR approach

We hold regular meetings with the EA. See our response to IPRG recommendation (S2.3). At these meetings, we have discussed our approach to a range of issues (including the treatment of human activities on the beach). The EA has provided feedback, which we have taken account of. However, we recognise that we cannot regard such feedback as agreement before the 2011 ESC is submitted.

3 KEY ISSUES AND CONCLUSIONS

We recognise that the IPRG undertook their review at a time when the structure and approach for the 2011 ESC were still being finalised. As a consequence, the IPRG review does not fully recognise LLWR's planning at the time of the review. Many of the issues raised by IPRG in their recommendations had already been identified by LLWR. Notwithstanding this, we have found the review process valuable, and have ensured that, where appropriate, the key issues raised by IPRG are addressed in the 2011 ESC.

In particular, we believe that our approach to reporting the safety case fully addresses the 'communications' issues raised by the IPRG. The document structure for the 2011 ESC is explained in our response to IPRG recommendation (S2.6).

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