

Low Level Waste Repository

## **LLWR Lifetime Project**

### **Response to the Independent Peer Review of the LLWR Requirement 2 Submission to the Environment Agency**

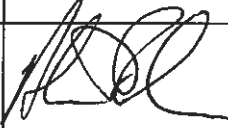
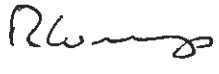
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**LLWR LTP 10008**

**Issue 1**

**Date: September 2008**

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# **Response to the Independent Peer Review of the LLWR's Requirement 2 Submission to the Environment Agency**

**A J Baker**

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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 safety case. A peer review panel (PRP) comprising six members was therefore appointed in 2007. A key part of their work to date has been a review of a recent submission to the Environment Agency, concerned with long-term environmental impacts. The objective of this report is to indicate how the LLWR proposes to address the comments made by the PRP.

Overall, the comments from the peer review process were very helpful in improving the quality of our submission and in helping to define the programme of future work, which is now underway.

We accept the comments and suggestions made by the PRP, except in a small number of cases that have been highlighted in this report. We see these areas of disagreement as priorities for further engagement with the PRP and with the regulators.

In terms of their key comments, we agree with the Peer Review Panel that the submission does not provide a complete demonstration that Best Practicable Means have been used to ensure that risks are as low as reasonably achievable (paragraph 138). This requires further options and optimisation studies that are part of our forward programme.

We note and agree with the peer review comments that the following are required and have constructed our future programme accordingly:

- good planning;
- a fuller treatment of uncertainty;
- good links between work on engineering design and long-term safety;
- a fuller treatment of the radiological impacts arising from coastal erosion;
- building confidence in the understanding of the site hydrogeology;
- further consideration of the merits of selective waste retrieval.

We agree with the comment (paragraph 142) that consideration of the future use of the LLWR is required in consultation with regulators and stakeholders. We envisage that such work will be undertaken as part of the NDA's programme of work to develop a National LLW Strategy, which the LLWR is supporting.

## TABLE OF CONTENTS

<b>1</b>	<b>INTRODUCTION</b>	<b>5</b>
<b>2.</b>	<b>RESPONSE</b>	<b>7</b>
2.1	Assessment Purpose and Philosophy (subsection 3.1.1) .....	7
2.2	Regulatory Criteria and Assessments Endpoints (subsection 3.1.2) .....	7
2.3	Assessment Timeframe (subsection 3.1.3) .....	7
2.4	Waste Inventory (subsection 3.2.1) .....	7
2.5	Engineered Facility (subsection 3.2.2) .....	8
2.6	Geology and Hydrogeology (subsection 3.2.3) .....	8
2.7	Site Evolution (subsection 3.2.4) .....	8
2.8	Scenarios (subsection 3.3.1) .....	9
2.9	Potentially Exposed Groups (subsection 3.3.2) .....	9
2.10	Assessment Modelling – Engineering performance (subsection 3.4.1) .....	9
2.11	Assessment Modelling - Source Term (subsection 3.4.2) .....	9
2.12	Assessment Modelling – Groundwater Flow (subsection 3.4.3) .....	9
2.13	Assessment Modelling – Coastal Erosion (subsection 3.4.4) .....	10
2.14	Assessment Modelling – Radon and Thoron Doses (subsection 3.4.5) .....	10
2.15	Assessment Modelling – Human Intrusion (subsection 3.4.6) .....	10
2.16	Quality Assurance (subsection 3.5.1) .....	11
2.17	Assessment Results (subsection 3.5.2) .....	11
2.18	Comparison with Regulatory Criteria (subsection 3.5.3) .....	11
2.19	Options Analysis (Section 4) .....	11
<b>3.</b>	<b>KEY ISSUES AND CONCLUSIONS</b> .....	<b>12</b>
	<b>REFERENCES</b> .....	<b>13</b>

## 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.

To dispose of radioactive waste the SLC requires an authorisation from the Environment Agency (EA). The LLWR's current authorisation, with an effective date of 1st May 2006, is split into a number of schedules, of which Schedule 9 is a list of improvements and additional information that the operator must supply. On 1<sup>st</sup> May 2008, the LLWR made a submission to the Environment Agency in response to Requirement 2 of Schedule 9 ('the submission'). The submission included:

- information to show that our work is founded on national and international best practice;
- an assessment of options, to identify and assess the ways of managing the long-term impact of the Trenches;
- an analysis of the total 'radiological capacity' of the Vaults (i.e. the total quantity of radionuclides that can be disposed while remaining consistent with the safety case);
- an updated, but interim view of site characteristics, the evolution of the engineered barriers and long-term performance.

The submission comprised five volumes (LLWR, 2008a to 2008e):

Volume 1: Managing existing liabilities and future disposals at the LLWR;  
Volume 2: Assessment of options for reducing future impacts from the LLWR;  
Volume 3: Inventory and near field;  
Volume 4: Site understanding;  
Volume 5: Performance update for the LLWR.

It is important to observe that the submission did not provide a complete Environmental Safety Case (ESC) for the LLWR and that there is still a significant amount of work to undertake before completing an ESC in 2011. Thus, the analysis of performance was preliminary in a number of respects. Nonetheless, the LLWR considers that a much improved view of the long-term performance of the facility was obtained compared with that available from the 2002 assessment (BNFL, 2002a).

The LLWR is committed to a process of peer review as part of the process of building a robust safety case. A peer review panel (PRP) comprising six members was therefore appointed in 2007. A key part of their work to date has been a review of the submission identified above (Bennett et al., 2008).

The PRP was supplied with copies of early drafts of the five documents in March and April 2008. The PRP supplied detailed written comments on those drafts. These comments were then considered and addressed to the extent possible as part of the work to review and revise the documents. After the completion and issue of the documents, the final versions were

supplied to the PRP together with the LLWR's detailed written responses to the comments that had previously been received. The PRP considered which comments had been satisfactorily addressed and which were still outstanding. On this basis they provided the final review (Bennett et al., 2008).

A draft of the PRP's report was provided to the LLWR in July 2008. The LLWR's team commented on matters of factual accuracy, but not at that stage on the technical issues. A revised version of the report was subsequently issued.

The objective of this document is to indicate how the LLWR proposes to address the PRP's findings as part of a future programme of technical work. A commentary and response to the PRP's detailed findings are set out in section 2 and key issues and conclusions are summarised in section 3.



## **2. RESPONSE**

This section contains a response to the detailed peer review comments. The responses are organised in subsections corresponding to the subsections in the PRP's report (Bennett et al., 2008). We have not attempted to provide a response to every detailed comment offered by the PRP, but rather to identify the key issues and to indicate how they are being addressed.

### *2.1 Assessment Purpose and Philosophy (subsection 3.1.1)*

As noted in paragraph 24 by the PRP and in the LLWR's submission (LLWR, 2008a), it is important to understand that a comprehensive post-closure safety case has not been completed and was not planned to be completed at this stage of the LLWR's programme. The LLWR has proposed a detailed technical programme that, subject to approval by the NDA, will lead to the production of a comprehensive Environmental Safety Case (ESC) in 2011.

We agree with the PRP that a more thorough treatment of uncertainty will be required in the ESC than in the submission (paragraph 25) and this will be addressed by a number of activities within our future technical programme. Initially, we are producing a document setting out our overall approach to the ESC – this will include information on our proposed approach to dealing with uncertainty.

### *2.2 Regulatory Criteria and Assessments Endpoints (subsection 3.1.2)*

We agree that it may be necessary to consider regulatory criteria different from those adopted in our submission (see paragraph 29). Any uncertainties in this respect should be removed because the environment agencies will be issuing revised guidance well before the preparation of the ESC (Environment agencies, 2008).

We disagree with the PRP's contention that '*risk has not been evaluated in any sense that could properly be compared on a like-for-like basis with the mean annual individual risk target ...*' (paragraph 30). We believe that it is appropriate to compare a risk estimate from a deterministic case with the risk target, provided that the case is a reasonable case and the associated uncertainties or bias are indicated. A probabilistic calculation is not necessarily required for such comparison. Nevertheless, we would agree with the PRP that some of the impact calculations require further development and consideration, particularly in respect of a fuller treatment of uncertainty and the presentation of a wider range of results.

### *2.3 Assessment Timeframe (subsection 3.1.3)*

We agree with the PRP's comments in this subsection.

### *2.4 Waste Inventory (subsection 3.2.1)*

We agree with the PRP that consideration of the uncertainty in the inventory is necessary, based on a knowledge of the wastes and the physical and chemical processes to which they have been subject (paragraph 38). A key activity is planned in our future programme, related to a consideration of such uncertainties.

As noted by the PRP, the submission does not consider the effects of alternative strategies leading to the disposal of different categories of wastes at the LLWR (paragraph 40). Rather, as set out in LLWR (2008a), the appropriate disposal routes for different categories of waste will be determined as part of separate studies to develop the NDA's National LLW strategy. It is likely that the ESC will reference such strategy studies, rather than providing the primary evaluation of appropriate disposal routes for these wastes. Appropriate information on the long-term performance of the LLWR will be provided to support these studies.

#### *2.5 Engineered Facility (subsection 3.2.2)*

We acknowledge that the submission does not include consideration of vault design choices (paragraph 43). This was the subject of a separate study, (Fleming, 2007), which has been submitted to the Environment Agency. The LLWR is planning further optimisation studies to address the questions raised by the PRP in paragraphs 44 to 46.

#### *2.6 Geology and Hydrogeology (subsection 3.2.3)*

We acknowledge (paragraphs 48 to 55) that there is further work to undertake in testing and developing confidence in the hydrogeological conceptual and numerical models. We propose to undertake a number of studies to take forward our analysis. These will include:

- Consideration of alternative conceptual models of the hydrogeology and, if such models are supportable, consideration of their implications in terms of long-term environmental impact;
- Consideration of whether there are any geostatistical representations of the system that could be usefully explored in modelling;
- Following a more rigorous approach to calibration;
- Investigating the possibility of further boreholes between the site and the coast to obtain more geological and hydrogeological information.

There is limited scope for using information on the distribution of tritium as a constraint on the models. It can be ensured that numerical models predict the same general distribution of contaminants as observed and that observed travel times are consistent with those predicted by the models. However, more detailed analyses are difficult because the source term for the tritium is poorly defined.

#### *2.7 Site Evolution (subsection 3.2.4)*

The PRP raises queries about the overall suitability of the site in view of expected coastal erosion. As noted by the PRP, the LLWR considers that the merits of the LLWR as a disposal facility for certain sorts of waste as opposed to any other disposal solution, should be considered as part of the development of the NDA's National LLW strategy (paragraphs 58 and 59). Such consideration needs to include a comparison between continuing disposal at the LLWR and other disposal solutions. We agree very much with the PRP that the

consideration of strategy needs to be well integrated with an understanding of the performance of the LLWR. Arrangements are in place to ensure that this occurs.

#### *2.8 Scenarios (subsection 3.3.1)*

We agree with the PRP's comments in this subsection.

#### *2.9 Potentially Exposed Groups (subsection 3.3.2)*

Radiological impacts have not been calculated to all of the potentially exposed groups (PEGs), identified by Thorne (2007) (paragraph 66). This was explicitly acknowledged in our submission (e.g. the second from last bullet point on page 40 of Volume 1 of our submission). We are currently taking forward work to assess impacts to members of PEGs living in or around a potential lagoon. We agree that there are some additional exposure pathways, not considered in our submission (e.g. gas release through defects in the cap – see paragraph 66) that will require consideration in the fuller assessment that will be provided as part of the ESC in 2011.

#### *2.10 Assessment Modelling – Engineering performance (subsection 3.4.1)*

The LLWR is committed to a review and update of our approach to modelling the degradation of the engineered barriers and the effect on water flows through the facility (paragraphs 73 and 74). This will include reviewing and challenging the views reached in the recent elicitation process (paragraph 73). It is noted, however, that many of the views reached during this process are supported by arguments set out in an underlying technical report (Thorne, 2008).

#### *2.11 Assessment Modelling - Source Term (subsection 3.4.2)*

It is noted that a well-mixed equilibrium source term model has been used in the assessment model of the groundwater pathway in contrast to the more complex DRINK model that was used in the 2002 PCSC (c.f. paragraph 75). However, the overall conceptual model and certain parameter values still draw on results obtained with the DRINK model (BNFL, 2002b).

#### *2.12 Assessment Modelling – Groundwater Flow (subsection 3.4.3)*

We agree that comprehensive information on the assessment model of the groundwater pathway and its basis should be provided (see paragraph 80). Such information was not contained in the top-level documents reviewed by the PRP, but was contained in an important supporting reference (Paksy and Henderson, 2008) that was only completed recently. For clarity, we note that Case A does include the effects of degradation of the engineered barriers, but only considers vertical flows through the cap, rather than any lateral flows through the cut-off walls.

We noted in our submission that the treatment of the water abstraction well was preliminary and, hence, agree that the approach needs further development (paragraph 80, final bullet).

We are taking forward work at the moment to develop and then implement a revised methodology.

#### 2.13 Assessment Modelling – Coastal Erosion (subsection 3.4.4)

The PRP have identified some aspects of the current assessment models that appear optimistic (paragraph 83). We agree that some of these cases need to be looked at further and this will be undertaken prior to the 2011 ESC. However, we would continue to argue that it is reasonable to assume that buildings will not be constructed on an eroding coastline that has intersected the repository

#### 2.14 Assessment Modelling – Radon and Thoron Doses (subsection 3.4.5)

The PRP is '*uneasy about the apparent extent of averaging in the derivation of the ... model*', that '*most of the large variation in radon levels in dwellings ... is not explained by the new model.*' and '*that it would be necessary for the next safety case to fully acknowledge and address the uncertainties in its use*' We agree that discussion of uncertainties is important, but we feel that we have offered such a discussion in Volume 5 of our submission (LLWR, 2008e). The uncertainties are deliberately not represented in the model, which represents a UK average dwelling case. In our view, such an average case is appropriate and consistent with the widely used reference biosphere approach.

We agree with the PRP that the radon and thoron model requires further review and should be treated as interim (paragraph 91). This is acknowledged in our submission. We also agree that the implications of cap degradation need to be considered (paragraph 90). Further work on the model will be undertaken prior to the 2011 ESC.

#### 2.15 Assessment Modelling – Human Intrusion (subsection 3.4.6)

We disagree with the PRP's view of the appropriate treatment of human intrusion in repository safety assessments (paragraphs 95 to 101). The PRP considers that '*if arguments are to be made regarding the probability of human intrusion, then logically the assessed risk from intrusion should be compared to a risk-based standard*'. In contrast, we consider that a discussion of relative likelihood or whether the case is reasonable or extreme is important to provide perspective to the results of any specific human intrusion calculation case, whatever the measure of performance. We believe that reasonable, not extreme, cases should be compared with the dose guidance level. It is appropriate, in our view, to discuss the potential impact of passive institutional controls on the likelihood of occurrence of different human intrusion scenarios, although we would not advocate incorporating any corresponding probabilities in calculations of impact (c.f. paragraph 95).

The source for this discussion is ICRP Publication 81 (ICRP, 2000), which suggests, when considering the implications of human intrusion, that '*it is not appropriate to apply the Commission's constraint for radioactive waste disposal ... because there is little or no scientific basis for predicting the nature or probability of future human actions and also because, by definition, an intrusion event bypasses some or all of the barriers that have been put in place as part of the optimisation of protection.*' Rather, it is suggested that comparisons should be made with appropriate dose criteria and this approach has been adopted in the

environment agencies' draft guidance (Environment agencies, 2008). In the view of ICRP 81, the relative likelihoods of different cases are a proper consideration, particularly in the context of optimisation (for example, see §(16), bullet 2, §(42), §(61), §(62) of ICRP Publication 81).

The LLWR is not advocating quantitative consideration of the probabilities of human intrusion events, but is of the view that a discussion of relative likelihood and whether a case is reasonable or extreme provides important context. Steps to reduce the likelihood of human intrusion are an important part of design optimisation for repositories. However, it is very important that different human intrusion scenarios are considered in context and that unusual or extreme events are not used as the basis for optimisation decisions.

Recognising that the treatment of human intrusion is a source of debate, we propose to discuss the relevant issues with the Environment Agency in the context of their draft guidance (Environment agencies, 2008).

#### *2.16 Quality Assurance (subsection 3.5.1)*

We agree that quality assurance is a fundamental requirement.

The PRP note that the assessment is not reproducible from the information provided in Volumes 1 to 5. However, detailed information is provided in underlying documents that were not available to the PRP for the groundwater pathway (Henderson and Paksy, 2008), the gas pathway (Ball et al., 2008) and coastal erosion and human intrusion (Galais and Fowler, 2008). We are committed to providing a fully traceable account of the assessment as part of the 2011 ESC.

#### *2.17 Assessment Results (subsection 3.5.2)*

We agree that the issues raised in paragraph 108 deserve further consideration.

#### *2.18 Comparison with Regulatory Criteria (subsection 3.5.3)*

We agree that certain regulatory criteria may be different from the criteria with which calculated impacts were compared as part of the submission (paragraph 110).

#### *2.19 Options Analysis (Section 4)*

We welcome the PRP's views on the different options, which are consistent with the LLWR's position. We plan that further attention will be given to the question of selective retrieval. Overall, the question of optimisation is far from closed. We agree that there are questions over the design of the facility and its management that require further consideration. The LLWR has a number of options assessments activities over the next two years that will address these issues.

### **3. KEY ISSUES AND CONCLUSIONS**

The comments from the peer review process have been very helpful in improving the quality of our submission and in helping to define a programme of future work. We have found the process constructive. However, the process could clearly be improved by allowing more time for the peer review process and for the LLWR to take account of comments. We will schedule more time for the process during the development of the 2011 ESC.

We accept most of the comments and suggestions except in a small number of cases that have been highlighted in Section 2 of this Report. We see some of the areas of disagreement as priorities for further engagement with the PRP and with the regulators.

In terms of the overall comments in the Conclusions of the PRP report (Section 5), we agree with the PRP that the submission does not provide a complete demonstration that Best Practicable Means have been used to ensure that risks are as low as reasonably achievable (paragraph 138). This requires further options and optimisation studies that are planned to take place before the time of the ESC.

We note and agree with the peer review comments that (paragraph 142) the following are required and have constructed our future programme accordingly:

- good planning;
- a fuller treatment of uncertainty;
- good links between work on engineering design and long-term safety;
- a fuller treatment of the radiological impacts arising from coastal erosion;
- building confidence in the understanding of the site hydrogeology;
- further consideration of the merits of selective waste retrieval.

We agree with the comment (paragraph 142) that consideration of the future use of the LLWR is required in consultation with regulators and stakeholders. We envisage that such work will be undertaken as part of the NDA's programme of work to develop the NDA's National LLW Strategy, which the LLWR is supporting.

**REFERENCES**

Ball, M. D., Willans, M., Cooper, S. and Lennon, C., 2008. LLWR Lifetime Project: Review of the Gas Pathway Analysis, Nexia Solutions Report (08) 9277.

Bennett, D., Bath, A., Fleming, G., Garrard, G., Holton, D. and Jones, S., 2008. Independent Peer Review of LLWR Response to Environment Agency Schedule 9 Requirement 2.

BNFL, 2002a. Drigg Post-Closure Safety Case: Overview Report.

BNFL, 2002b. Drigg Post-Closure Safety Case: Near-field Biogeochemistry.

Environment Agency, Scottish Environment Protection Agency, Environment and Heritage Service Northern Ireland, 2008. Near-Surface Disposal Facilities on Land for Solid Radioactive Wastes: Guidance on Requirement for Authorisation, Draft for Public Consultation, 15 May 2008.

Fleming, C., 2007. BPM Document, LLWR Modular Vaults Project, SP/102917/460005916/PROJ/00004, Issue P3.

International Commission on Radiological Protection, 2000. Radiation Protection Recommendations as Applied to the Disposal of Long-lived Solid Radioactive Waste, ICRP Publication 81.

LLWR, 2008a. Volume 1: Managing Existing Liabilities and Future Disposals at the LLWR, LLWR LTP, 10001.

LLWR, 2008b. Volume 2: Assessment of Options for Reducing Future Impacts from the LLWR, LLWR LTP 10002.

LLWR, 2008c. Volume 3: Inventory and Near Field, LLWR LTP 10003.

LLWR, 2008d. Volume 4: Site Understanding, LLWR LTP 10004.

LLWR, 2008e. Volume 5: Performance Update for the LLWR, LLWR LTP 10005.

Galais, N. and Fowler, L, 2008. LLWR Lifetime Project: Assessment of Potential Impacts from Human Intrusion and Coastal Erosion at the LLWR, Nexia Solutions Report (07) 9278.

Paksy, A and Henderson, E., 2008. Assessment of Radiological Impacts for the Groundwater Pathway, Nexia (08) 9449.

Thorne, M.C., 2008. Estimates of Cap Infiltration and Erosion, Nexia Solutions Report (08) 9274.