The LLWR's 2011 Environmental Safety Case – 12143

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ABSTRACT

The Low Level Waste Repository (LLWR) is the United Kingdom's principal facility for the disposal of LLW. The LLWR recently submitted an Environmental Safety Case (ESC), which will support applications to regulatory and government authorities to dispose of LLW and to start to install final closure engineering. The ESC is a major submission, with important implications for the future of the LLWR and the United Kingdom's management of LLW. The paper describes the context of the ESC, the ESC, its results and conclusions, and its implementation. The description shows that our ESC is a modern safety case developed as a range of safety arguments concerning our management, scientific and technical understanding, optimisation of the facility, as well as assessment calculations.

INTRODUCTION

The Low Level Waste Repository (LLWR) is the United Kingdom's principal facility for the disposal of LLW. The LLWR submitted an Environmental Safety Case (ESC) to the Environment Agency on the 1st May 2011 [1]. The ESC will support applications, to the environmental regulator and the local government authority, to dispose of LLW and to start to install final closure engineering. The ESC is a major submission that will decide the future use of the LLWR and has important implications for the success of the UK's LLW strategy and operational and decommissioning programmes in the nuclear industry.

DESCRIPTION OF THE LLWR

The LLWR is owned by the Nuclear Decommissioning Authority, which is a non-departmental public body created under the Energy Act 2004. The Nuclear Decommissioning Authority is a strategic authority that owns a number of civil nuclear sites and associated nuclear liabilities and assets in the United Kingdom. The LLWR is operated on behalf of the Nuclear Decommissioning Authority by a Site Licence Company, the LLW Repository Ltd.

The LLWR is located in the Northwest of England on the West Cumbrian coastal plain, close to the village of Drigg and approximately five kilometres south-east of Sellafield. Apart from nearby Sellafield, the area is predominantly rural. The area along the coast adjacent to the site is designated as a Site of Special Scientific Interest (SSSI), known as the Drigg Coast SSSI. Along the north-eastern boundary is the Carlisle to Barrow-in-Furness railway line, a siding from which enters the site for the delivery of waste containers and other items and materials. The Ravenglass Estuary lies to the south. The Cumbrian mountains rise further to the east. The LLWR lies outside the Lake District National Park.

The LLWR site is about two kilometres long and half a kilometre wide and lies on a northwest-southeast axis. A boundary fence, designed to prevent unauthorised access, encloses the site. The northern half of the site is used for waste disposal. The southwestern boundary of the northern area of the site borders the SSSI. The height of the site above sea level varies from about 5m at its southern end to 20m at its northern end. The Drigg Stream follows a partly engineered course through the site roughly parallel with the southwestern site boundary. It leaves the site to the south and discharges into the River Irt, which is tidal at that point, and forms the northern arm of the Ravenglass Estuary.

The site of the LLWR was first developed in 1940 as a Royal Ordnance Factory (ROF) for the production of TNT.

LLW has been disposed at the site since 1959. For the first 30 years, drummed, bagged or loose waste was tumble-tipped into seven consecutively constructed trenches. The trenches are currently covered by an interim cap of soil, containing a plastic membrane to minimise the infiltration of water into the wastes. The trenches contain about 500,000 m^3 of waste.

From the late 1980s onwards, disposal operations were upgraded to modern standards. A concrete disposal vault was constructed, Vault 8, allowing the disposal of wastes in containers. Waste was first put into Vault 8 in 1988. The first seven years of the operation of Vault 8 overlapped with completion of disposals to Trench 7. Construction of a second vault, Vault 9, was completed in December 2010. Waste started to be placed in Vault 9, in a prepared area, in 2009 prior to the vault's final completion.

Most wastes are received within steel half-height ISO containers or third-height ISO containers, which are filled with cement grout at the site and then stacked within one of the vaults. Currently, larger items are placed or grouted directly within specific areas of the Vault 8. Vault 8 contains about 200,000 m^3 of waste containers.

It was originally planned that waste containers would be stacked to a height of four half-height ISO containers in Vault 8. Waste in the vault up to this height is disposed – see below. The vault is now almost full to this original design capacity. Some waste containers are now stored in Vault 8 in higher stacks above the disposed waste. Waste is also stored, rather than disposed, in Vault 9 – again, see below.

Water infiltrating into the trenches and rain water entering Vaults 8 and 9 is collected and sampled prior to discharge to the sea via a marine pipeline in accordance with our discharge consent.

Figure 1 shows a labelled recent aerial photograph of the facility.

NATIONAL POLICY AND STRATEGY AND REGULATORY CONTEXT

LLW is defined in the United Kingdom as radioactive waste having a radioactive content not exceeding 4 GBq t^{-1} of alpha or 12 GBq t^{-1} of beta/gamma activity. The definition is based only on specific activity and at the time of disposal LLW can contain long-lived radionuclides.

The Nuclear Decommissioning Authority has published a '*UK Strategy for the Management of Solid Low Level Radioactive Waste from the Nuclear Industry*' [2]. The Strategy has been prepared by the NDA for the UK Government and devolved administrations in response to their '*Policy for the Long Term Management of Solid Low Level Radioactive Waste in the United Kingdom*' [3], published in 2007. The United Kingdom's Strategy is to make '*best use of existing LLW management assets*' for the management of LLW. This approach is based on a Strategic Environmental Assessment (SEA), conducted to support the development of the Strategy. '*Best use of existing LLW management assets*' means continuing to use the LLWR to dispose of LLW, but only LLW that requires the protection provided by disposal in vaults. It also means minimising the volume of LLW that needs to be disposed at the LLWR, while maximising the capacity of the facility to safely take waste. An important part of the United Kingdom's Strategy is the implementation of the waste hierarchy to minimise the volume of LLW that needs vault disposal. The Strategy recognises that the LLWR can only continue to be used to dispose of LLW if we can demonstrate that the facility is safe using an environmental safety case.

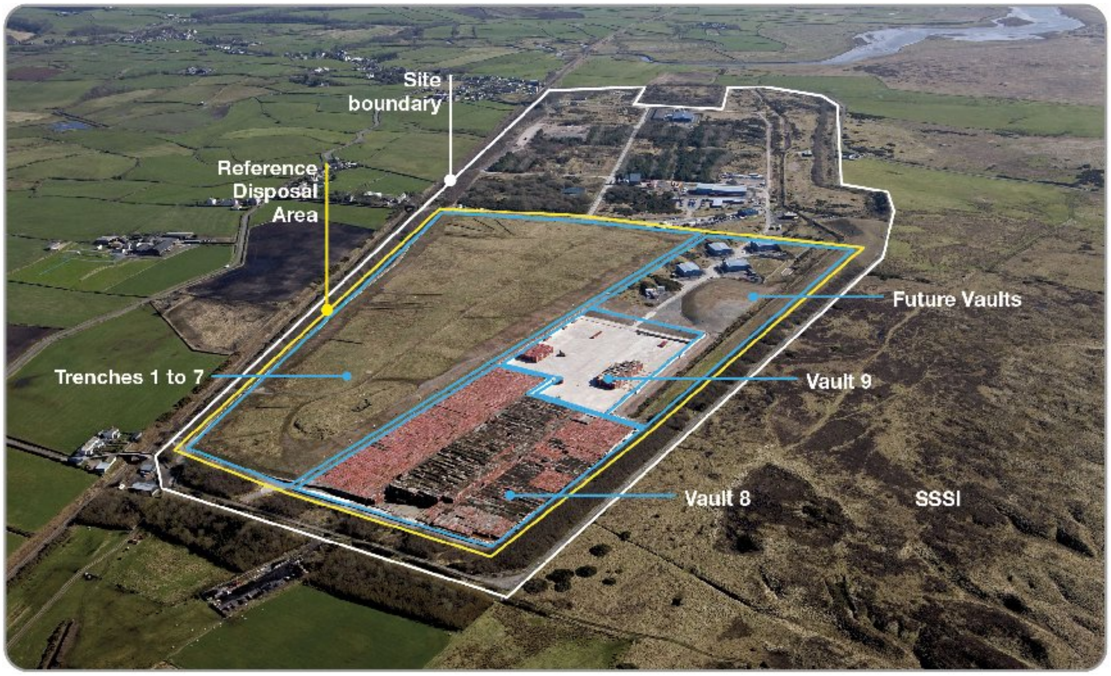

Fig 1. The LLWR viewed from the north

The disposal of radioactive waste in England and Wales is regulated by the Environment Agency under the Environmental Permitting (England and Wales) Regulations 2010 [4]. The Environment Agency issues permits that set out the conditions under which radioactive wastes may be disposed. The LLWR's current Permit is based on the Environment Agency's review of safety cases prepared by the previous site operator and submitted in 2002. The Environment Agency considered that these safety cases, and especially the safety case addressing the safety of the facility in the long term after it closes (the Post-closure Safety Case or PCSC [5]), had failed to make '*an adequate or robust argument for continued disposals of LLW*'. The Environment Agency decided, therefore, that continued disposal of LLW would be authorised only until Vault 8 was filled to its originally planned capacity, and that any further waste received by the facility could only be stored and not disposed. Hence, the waste being placed in Vault 9, and the higher stacked waste in Vault 8, is stored and not disposed. The Environment Agency placed a requirement on the site operator to present a revised environmental safety case by the 1st May 2011. The purpose of our 2011 ESC is, therefore, to meet the Environment Agency's requirement to submit a revised environmental safety case. The objective has been to develop and present an ESC that demonstrates to the Environment Agency that it is safe to continue to dispose of LLW at the LLWR. In achieving this objective, the ESC will also provide a sound basis for future management of the site by LLW Repository Ltd and regulation of the site by the Environment Agency.

REGULATORY GUIDANCE AND SCOPE

The United Kingdom's environment agencies, including the Environment Agency, have provided guidance on the requirements that a near-surface disposal facility must fulfil. These requirements are set out in the '*Guidance on Requirements for Authorisation*' (the GRA) [6]. That a facility meets these requirements must be demonstrated in an ESC. The GRA sets out the principles that must be followed, and formal requirements that must be met, in developing an ESC. The GRA describes what environmental safety criteria must be met and what evidence must be provided in an ESC. The principles and requirements cover environmental safety both during operations at a facility and during and after closure, for however long the wastes will remain a potential hazard.

An ESC is not concerned with conventional safety, including demonstrating protection of workers, or security, which are regulated separately by the Office for Nuclear Regulation. An ESC is also not concerned with conventional environmental impacts, for example, traffic, noise, and visual amenity, which are dealt with under local planning procedures.

The GRA sets out high-level principles and requirements and is generally non-prescriptive. The fourteen main requirements are listed in Figure 2. It states dose constraints for the period during which a Permit is in force, termed the period of authorisation, and risk and dose guidance levels for the period after the release of the site from regulatory control. During the period of authorisation, the effective dose from the facility to a representative member of the critical group should not exceed a source-related dose constraint of 0.3 mSv per year[1]. After the period of authorisation, the assessed radiological risk from a disposal facility to a person representative of those at greatest risk should be consistent with a risk guidance level of 10^{-6} per year. The potential consequences of human intrusion should be assessed on the basis that it is likely to occur, and the assessed effective dose to any person during and after the assumed intrusion should not exceed a dose guidance level in the range of around 3 mSv per year to around 20 mSv per year. Values towards the lower end of the range are applicable to assessed exposures continuing over a period of years, while the values towards the upper end of the range are applicable to assessed exposures that are only short term.

PRESENTATION AND KEY SAFETY ARGUMENTS

The GRA defines an environmental safety case as:

> '*a set of claims concerning the environmental safety of disposals of solid radioactive waste, substantiated by a structured collection of arguments and evidence.*'

Following this definition, the LLWR's 2011 ESC is presented as a set of twenty-six key safety arguments. The arguments are structured into four sets around a high-level statement of our safety case:

- We have worked within a sound management framework and firm safety culture, while engaging in dialogue with stakeholders.
- We have characterised and established a sufficient understanding of the LLWR site and facility, and their evolution, relevant to its environmental safety.

[1] A dose constraint of 20 microSv per year for members of the public through the groundwater pathway during the period of authorisation is expected to be added as part of the implementation of the 2006 Groundwater Directive.

- On which basis, we have carried out a comprehensive evaluation of options to arrive at an optimised Site Development Plan for the LLWR.
- We have assessed the environmental safety of the Site Development Plan, showing that impacts are appropriately low and consistent with regulatory guidance. Using our assessments, we have determined the radiological capacity of the facility and conditions under which waste may be safely accepted and disposed.

The four sets of arguments are:

- Management and dialogue;
- System characterisation and understanding;
- Optimisation and Site Development Plan;
- Assessment and conditions for waste acceptance.

The main ESC documentation is structured in two levels. There is one 'Level 1' '*Main Report*' containing a statement of the twenty-six key safety arguments. The Level 1 report also describes the context of the ESC, in summary the site, its history and environmental context, our approach to developing the ESC and our Environmental Safety Strategy and Site Development Plan, our future work programme, and progress since the previous safety cases. There are sixteen 'Level 2' reports containing the analyses and evidence supporting the key safety arguments, in groups corresponding to the sets of key safety arguments. The structure of the ESC allows clear links between the key safety arguments and the supporting evidence. It is also shown within the ESC how the key safety arguments meet the fourteen main requirements set out in the GRA. The grouping of arguments and their links to the fourteen main GRA requirements are shown in Figure 2. One Level 2 report is devoted to a linkage between the ESC content and the detailed requirements set out in the GRA. There is also a third level of documentation formed by the references to the ESC reports.

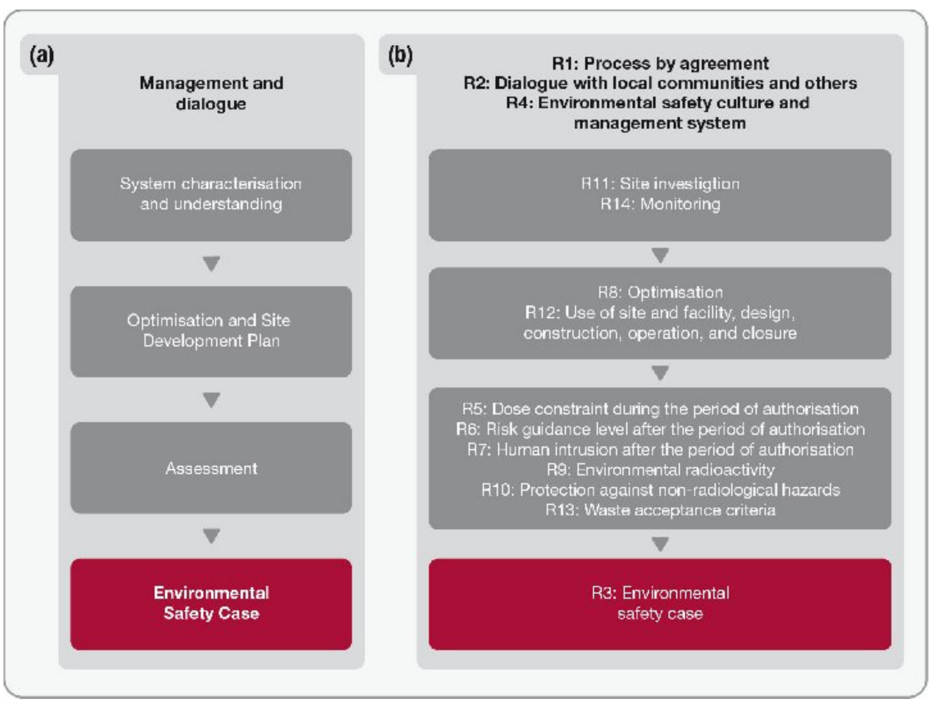

Fig 2. Grouping of key safety arguments (a) and links to regulatory requirements (b)

A brief summary of the safety arguments follows.

MANAGEMENT AND DIALOGUE

The first set of key safety arguments relates to the environmental management and culture of the LLWR and our dialogue with regulators and stakeholders:

- M1: Management system and safety culture;
- M2: Organisation of the ESC Project;
- M3: Dialogue with our environmental regulator;
- M4: Dialogue with our stakeholders;
- M5: Peer review.

LLWR has a sound management system, a positive environmental safety culture throughout its organisation, and is committed to high standards of environmental safety and quality. The ESC has been produced by our ESC Project within this safety culture and under the LLWR's management system. The Project team planned and undertook a work programme to provide appropriate, accurate and timely information and results to support the development of the ESC, and for LLWR and NDA decision making. The ESC Project team interacts with other LLWR teams to ensure the consistency of the ESC with other LLWR activities and to ensure other activities are aligned to meet the requirements and needs of the ESC.

We are committed to dialogue with our regulators, the NDA (the site owner), our waste consigners, and other local, national and international stakeholders. We communicate with our environmental regulator through submissions and reporting required under the terms of our environmental Permit and through regular liaison meetings. In particular, the regular liaison meetings have allowed us to present early technical views and findings and to discuss these and thus explore the consistency of our arguments and findings with the guidance set out in the GRA as we have developed the ESC. We have an extensive stakeholder engagement programme, which includes the development of the ESC, particularly in relation to optimisation and decisions about the Site Development Plan.

The development of the ESC has been subject to peer review by a standing, independent Peer Review Group from the United Kingdom, by an independent group of experts from other countries, and through review by a team of LLWR staff and contractors.

SYSTEM CHARACTERISATION AND UNDERSTANDING

The second set of key safety arguments relates to characterising and understanding the repository and its environment:

- S1: Characterising and understanding the wastes;
- S2: Characterising and understanding the near field;
- S3: Characterising and understanding the geology and hydrogeology;
- S4: Characterising and understanding the coastal environment;
- S5: Characterising and understanding the surface environment;
- S6: Monitoring.

Through our programmes of site investigation, measurements, research and detailed modelling, we have developed a sufficiently detailed and reliable description of the system to support both our evaluation of options for development of the site and assessments. In particular, this understanding is sufficient to support our estimates of performance required for comparison with regulatory guidance levels, and plans for future acceptance of waste at the facility.

The LLWR has been accepting wastes since 1959. Prior to the 1980s, characterisation of disposals was less detailed than is required now. Nevertheless, we have developed a good estimate of disposals of key radionuclides based on an examination of available disposal records. For example, the inventory of disposals of 'bulk' wastes from nearby Sellafield has been calculated using recent 'fingerprints' from the same or analogous facilities. Interviews have been held with staff who worked either at Sellafield or the repository. These interviews identified past practices that may not have been fully accounted for in the estimated inventory. On the other hand, our approach to estimating past disposals using modern fingerprints will have led to over-estimates of radionuclide inventories because of the amount of non-active waste that was disposed compared with now. Overall, we have concluded that any departures from accepted practices would not have had a significant effect on the estimated trench inventory. Based on the review of disposal records, we have produced maps of the distribution of key radionuclides in the trenches. This has been particularly useful in evaluating the merits of selective remediation, including selective retrieval of wastes. We have also analysed the United Kingdom's future inventory of LLW. An important objective has been to understand uncertainties in the amounts of key radionuclides that may be disposed to the LLWR. As well as an inventory of radionuclides, we have developed an inventory of other waste materials, to support our near-field modelling and assessment of the impacts of such materials.

A programme of review, experiments and modelling over a number of years has allowed us to develop a sufficiently detailed description of the engineered system and near field, and its possible evolutions, to support our evaluation of options for site engineering and assessment calculations. Our assessment analyses discussed below are based on detailed quantitative modelling using the Generalised Repository Model (GRM) [7]. This has provided an understanding of the evolution of pH, Eh and gas generation. For example, the calculation of partitioning of C-14 between different phases has been used in the assessments of the impacts of the release of C-14 through the gas and groundwater pathways. The information provided on the evolution of chemical conditions has fed into our elicitation of sorption coefficients and solubility limits for key radionuclides.

The LLWR is situated on relatively complex and heterogeneous Quaternary glacial materials overlying sandstones. A combination of intrusive (boreholes, trial pits, environmental sampling, hydrogeological testing) and non-intrusive (geophysics, bathymetry surveys, LiDAR survey, aerial photography) techniques have been used to characterise the geology and hydrogeology of the locality. The conceptual model developed is shown in Figure 4. A 3-D geological model has been developed to understand groundwater flow in the region of the site. The focus was on the distribution of lithologies and their hydrogeological properties, rather than understanding the processes that formed them. The geological model was then used as a basis for developing a 3-D hydrogeological model, calibrated against observed heads. The model is sufficiently detailed to allow the representation of the engineered features of the repository. This meant that the hydrogeological model was able to support optimisation studies and provided a key input into decision making. It also meant that the hydrogeological model could provide input into the near field and assessment models, allowing a simplified but transient model of flow through the repository to be implemented in the assessment model for the groundwater pathway suitable for deterministic and probabilistic calculations.

An important feature of the site with implications for the ESC is its coastal location. At its closest point, the disposal area is 400m from the sea (high-water mark). It is therefore important to consider the potential for coastal erosion of the site, taking into account global warming and consequent rise in sea level. A range of field, desk and modelling studies were undertaken examining the understanding of coastal evolution processes, geological and historical records, current coastal evolution in the locality and likely rates of erosion. We have concluded that the disposal vaults will begin to be eroded on a timescale of a few hundred to a few thousand years, with consequent disruption of the repository, with erosion of the vaults and trenches being complete within one to a few thousands of years. Coastal erosion has thus become an important aspect of our natural evolution scenario.

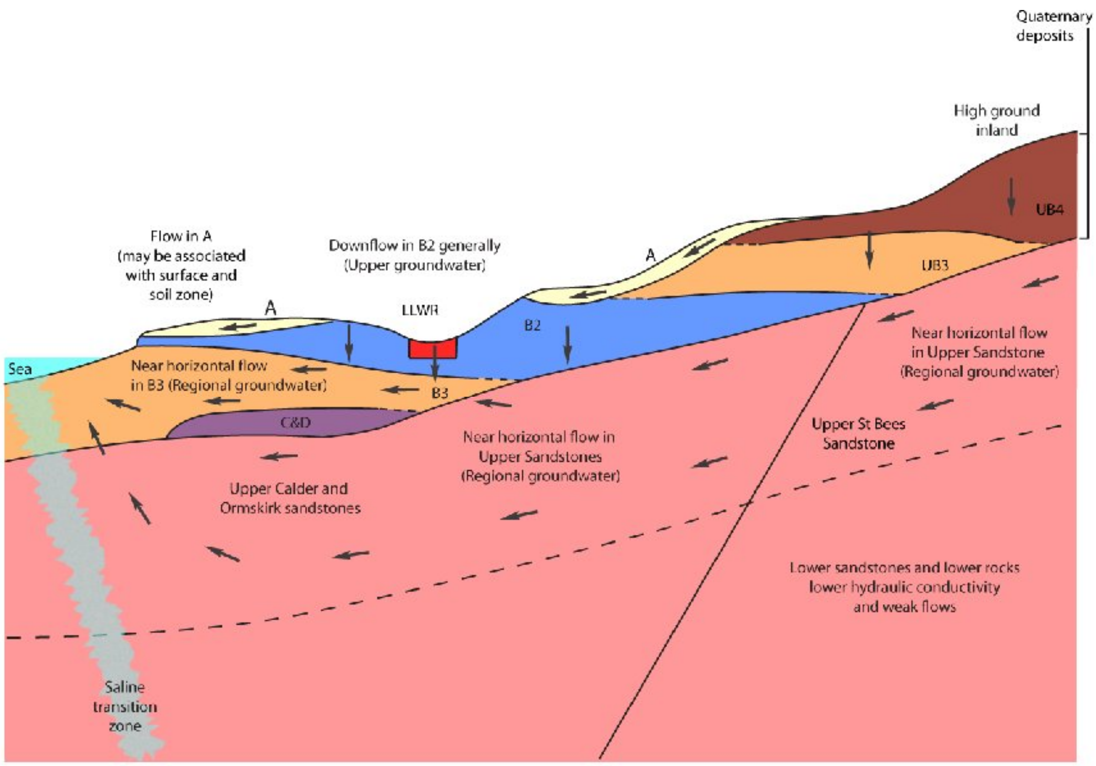

Fig 3. Schematic E-W section showing the hydrogeological conceptual model
(arrows show direction, not magnitude, of flow)

Our characterisation of present-day exposure pathways and critical groups, and future exposure pathways and potentially exposed groups, is based on established approaches and utilises appropriate data on local land and resource use and human habits. Our assessment of impacts to non-human biota is based on an understanding of the ecosystems present around the LLWR.

The LLWR undertakes a comprehensive range of monitoring. Results from environmental monitoring programmes provide direct evidence that releases of radioactivity from the site at the present day and in the past are low, and that doses to the local population calculated on the basis of monitoring are very low and consistent with regulatory requirements. The results also provide a baseline against which changes in future operations can be assessed. Monitoring results provide evidence of current site performance and provide a basis for forward estimation of performance. An ongoing monitoring programme throughout the period of authorisation will provide confidence that any unexpected and adverse aspects of performance will be recognised, so that action can be taken if needed, including any modification to the Site Development Plan.

OPTIMISATION AND SITE DEVELOPMENT PLAN

The third set of key safety arguments relates to optimisation of our Site Development Plan:

- O1: Remediation of past waste disposals;
- O2: Optimisation of future waste disposals;
- O3: Site engineering;
- O4: Waste emplacement strategies;
- O5: Management of run-off and leachate;
- O6: Management during closure.

We have carried out a comprehensive evaluation of options for the future development of the facility up to closure and beyond to arrive at an optimised Site Development Plan for the LLWR. A variety of approaches have been used to optimise different aspects; however, the emphasis has been on detailed technical analysis of options. For example, the application of our hydrogeological model and understanding played an important part in analysing and selecting our approach to site engineering. The assessments have been used, as they developed, to evaluate the environmental safety of alternative options. An optimised Site Development Plan has thus been developed that presents an appropriate combination of implementable options for the development of the site.

Key conclusions of the optimisation process were that remediation of past waste disposals, other than the implementation of final closure engineering, is not justified; and that the design of future vaults should be adapted to minimise the saturation of the wastes.

The work undertaken in this area has addressed a key failing of the previous safety cases identified by the regulator [8].

Optimisation and the Site Development Plan are discussed in more detail in another paper at this conference [9].

ASSESSMENT

The fourth set of key safety arguments relates to the assessments undertaken to estimate the impacts from the facility and the conclusions drawn from them:

- A1: Qualitative understanding and safety functions;
- A2: Quantitative analysis and modelling;
- A3: Uncertainty management;
- A4: Radiation doses during the Period of Authorisation;
- A5: Radiation doses and risks in the long term;
- A6: Non-radiological impacts;
- A7: Impacts on non-human biota;
- A8: Waste Acceptance Criteria and radiological capacity;
- A9: Extended capacity.

A comprehensive range of assessments have been undertaken, covering radiological impacts to humans and non-human biota, non-radiological impacts, during the periods of authorisation and after this period, and the likelihood of criticality, as required by the regulatory guidance. These have demonstrated that the repository performance is consistent with the regulatory constraints and guidance levels on dose and risk and other criteria relating to impacts from non-radiological materials and on non-human biota.

The final assessments were undertaken on the basis of the Site Development Plan discussed above. Two disposal areas and hence volumes were assessed, the 'Reference Disposal Area' (RDA) and 'Extended Disposal Area' (EDA). The RDA consists of the trenches and Vaults 8 to 14, while the EDA would extend the disposal area to allow the construction of six more vaults – see Figure 4. The EDA could accommodate all the wastes in the United Kingdom Radioactive Waste Inventory [10] assuming the application of the waste hierarchy.

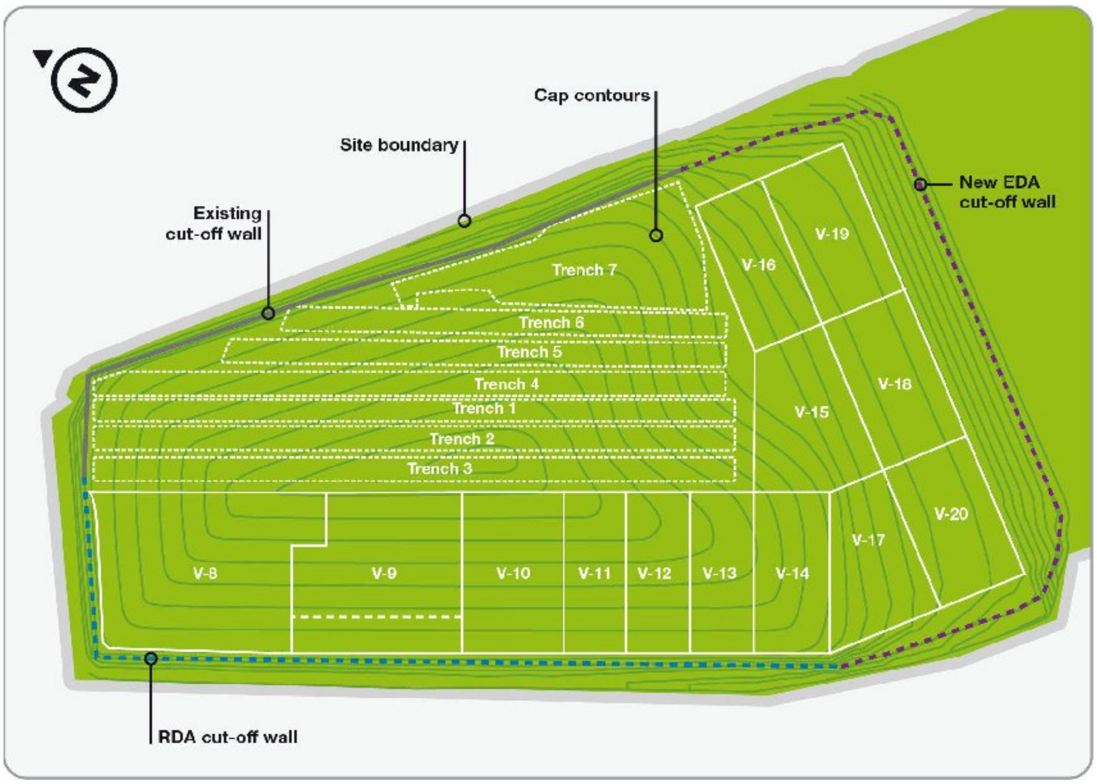

Fig 4. Schematic plan of the EDA repository

A range of improvements to data, methodologies and models have helped to reduce uncertainties and pessimisms and hence assessed doses and risks. An example is the creation of a new empirical model to estimate the effects of radon released from the wastes. The model is based on data relating radium concentrations in analogous soils to concentrations of radon in dwellings. This empirical model replaced a theoretically-based model for which some parameters were very uncertain. The release of radon would only cause an impact after final capping if the cap were damaged by human intrusion. A range of intrusion cases other than the construction of a house were also considered, such as site investigation.

An assessment of the impacts of the release of C-14 labelled gas drew on the results obtained from the detailed near-field model discussed above. Gas migration in the cap was considered and modelled. The migration process would produce some spreading and mixing, but no significant attenuation of fluxes. The calculated risk for a largely self-sufficient smallholder on the cap was calculated to be consistent with the regulatory guidance level about 300 years after completion of waste disposal. We believe our modelling of both the near field and biosphere contains significant conservatisms and further work is underway to examine these.

A key pathway is a future hypothetical water abstraction well drilled between the site and the coast. The drilling of a well is unlikely in the foreseeable future because much of the area is protected as a designated site encompassing special and rare habitats. A detailed assessment model has been developed using results obtained from the detailed near-field and hydrogeological models discussed above, and consideration of local practices relating to wells, including their frequency, depth of abstraction, and potentially exposed groups. Other groundwater pathways were considered in a similar way and included release to streams and to the marine environment.

Based on our scientific understanding of coastal erosion and characterisation of the local coastal environment, we have developed novel assessment methodologies and models to estimate the doses and risks that will arise as the LLWR is eroded, taking account of the distribution of the wastes within the repository and its progressive erosion. A range of potentially exposed groups has been considered, including recreational beach users, occupational users of the beach (e.g. inshore fishermen), and high-rate consumers of marine foodstuffs harvested from local waters. We have also considered intrusion into the eroding wastes by individuals and local contractors. The calculated doses and risks are consistent with regulatory guidance levels. As far as we are aware, the consideration of the impacts of coastal erosion in our ESC is unique in repository performance assessments.

Using a conventional classification of uncertainties in terms of scenarios (or cases), models and parameters, we have undertaken a comprehensive analysis of uncertainties.

For all the pathways considered in the assessments of radiological impacts to humans for the post-authorisation period, assessment models have been implemented in Gold*Sim*. A Gold*Sim* model was also used in the assessment of the impacts of non-radiological waste materials. The Environment Agency's ERICA methodology [11] was used for the non-human biota assessment.

WASTE ACCEPTANCE

An important outcome of the ESC is a fully underpinned set of proposed waste acceptance arrangements that will allow the repository to be operated consistently with the assumptions and assessed impacts of the ESC. A set of waste acceptance criteria have been rigorously derived from the ESC. We are also proposing to introduce a small number of waste emplacement strategies, i.e. control where in the waste stacks specific waste packages are emplaced. These strategies will increase the amounts of wastes that can be disposed. For example, one strategy will control the local voidage in the waste stacks, allowing packages with greater voidage to be disposed than would otherwise be the case, whilst ensuring differential settlement of the cap is kept to levels that will not compromise the performance of the cap. We are also intending to limit local concentrations of activity near the tops of the stacks, to reduce the potential impacts from human intrusion, and generally within the stacks to limit potential impacts from coastal erosion. The radiological assessments have also allowed us to calculate the total radiological capacity of the repository. The approaches to radiological emplacement strategies and controlling the total radiological inventory within the repository are based on the 'sum-of-fractions' methodology.

REVIEW AND IMPLEMENTATION

The Environment Agency is currently reviewing our ESC. During 2012, we plan to submit an application for a new permit to allow disposal of wastes in Vault 9 and higher stacked in Vault 8, and to start installation of the closure engineering including the proposed cut-off wall and final capping of Vault 8 and the adjacent strip of trenches. A planning application to the local planning authority has already been submitted and will be considered in parallel with the review of the ESC. We hope to receive a new permit during 2013.

Our current Permit requires us to manage the LLWR in accordance with our most up-to-date ESC. In accordance with this requirement, we are starting to implement the ESC to the extent possible while remaining consistent with the requirements in our current Permit. Our intention is to implement the ESC as a 'live' safety case using the well-developed processes and procedures used to maintain and implement our operational nuclear safety cases, adapted as necessary. The ESC will be used as a basis for assessing proposed modifications to the operation and closure of the facility, to ensure that they are consistent with the requirements of the ESC. The process will ensure that the Site Development Plan continues to remain optimised [9].

SUMMARY AND CONCLUSIONS

The LLWR's 2011 ESC is a major submission, with important implications for the future of the LLWR and the United Kingdom's management of LLW.

The description given of the scope of the ESC shows that it is a modern safety case developed as a range of safety arguments concerning our management, scientific and technical understanding, optimisation of the facility, as well as assessment calculations.

A number of key advances have been made since the previous submission. In particular, the 2011 ESC addresses the criticisms made by the regulator on the previous submission in 2002 [6], including those relating to lack of demonstration of optimisation, high calculated doses and risks compared with guidance levels, treatment of coastal erosion, and treatment of uncertainty.

The ESC is being reviewed by the environmental regulator and it is hoped that a new permit for disposal of LLW and installation of closure engineering, along with the appropriate planning permission, will be obtained during 2013. The ESC, including its proposed waste acceptance arrangements, is already being implemented by the LLWR where consistent with our current Permit.

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