

R W M D Report T e c h n i c a l N o t e

Geological Disposal Response to West Cumbria MRWS partnership Paper no 146

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| Prepared by: | Sarah Vines | |
| Checked by: | Neil Smart | |
| Approved by: | Alun Ellis | |

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Bibliography

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Readers are invited to provide feedback to the NDA on the contents, clarity and presentation of this report and on the means of improving the range of NDA reports published. Feedback should be addressed to:

John Dalton,
Head of Communications,
Nuclear Decommissioning Authority (Radioactive Waste Management Directorate),
Curie Avenue,
Harwell Campus,
Didcot,
Oxon,
OX11 0RH, UK

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Abstract

This document has been prepared to respond to key points raised in the paper by Professor Stuart Haszeldine for the West Cumbria MRWS partnership (Document 146).

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List of Contents

| | |
|--|-----------|
| Abstract | iv |
| 1 Introduction | 1 |
| 2 Key points raised in Professor Haszeldine's review and our response | 1 |
| 3 Summary | 7 |

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1 Introduction

NDA RWMD has recently published its R&D programme. The West Cumbria MRWS partnership asked Professor Stuart Haszeldine to review NDA's R&D programme (Document 146) and in this document we respond to the key points raised.

2 Key points raised in Professor Haszeldine's review and our response

Based on our interpretation of Professor Haszeldine's paper and the accompanying presentation, we have listed the key points below, together with our response. In doing this we have summarised some of the points made.

1. *The report does not provide a self-contained overview of its context within the NDA RWMD programme.*

We attempted to provide context in section 2 of the report. We try and strike a balance by providing the reader with sufficient context to understand the report but not repeat too much general text. Section 2 provides a reference to our "Steps towards implementation" report [1], which provides more information on the overall programme.

2. *The scope of the report keeps all options open for all types of setting of repository. Consequently none of this research is intended to be specific to West Cumbria.*

We agree. The report is deliberately generic, as is appropriate at this stage of the MRWS site selection process.

3. *An extremely wide range of current and recent research and project work has been summarized in this report.*

We are pleased that Professor Haszeldine has reached this view.

4. *The report is written in conventional English and uses accessible language.*

We thank Professor Haszeldine for this positive comment

5. *The 15 topics are sub-divided into 203 areas, each of which is analysed and described.*

The 15 topics are divided into 112 areas, but some of these address more than one driver. We would like to emphasise that in structuring our programme this way we are aiming to be comprehensive and this does not mean that all of these issues need to be closed out in the preparatory studies phase (MRWS stages 1-4).

6. *Provides a thorough coverage of known issues*

We thank Professor Haszeldine for this positive comment.

7. *Sensible and logically structured approach*

We are pleased that the approach to identifying and prioritising research needs, which we developed in consultation and over a period of time, is considered sensible and logical.

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8. *There is no clear audit trail. It is not clear how the 15 topics were elicited; the scoring method is obscure and relies on expert judgement. No external peer review mentioned. Therefore the process must be subject to unintended institutional bias.*

We describe in the document (p14) that the 15 topics are intended to be comprehensive. There are many ways in which we could structure the programme – the important question is whether we have missed anything and the comment (number 6) above, suggests that we have covered the known issues.

On p17 we explain that the process of identifying and prioritising R&D needs has been carried out by the RWMD intelligent customer for the work. It also explains that the output was reviewed by a team of managers within RWMD and that it has also been reviewed by our R&D advisory panel (which is external and independent). In publishing our R&D Programme overview and inviting feedback, we are providing an opportunity for all stakeholders to comment on our proposed R&D programme. We anticipate that we will receive many comments on the document and are delighted that the West Cumbria MRWS Partnership has commissioned a review of it. If, through feedback, we find that there are areas where there is significant disagreement about the R&D needs or our assessment of the priority, we will discuss these with stakeholders through workshops or other mechanisms and explore the range of views and the reasons for them. This could lead to a re-assessment of our R&D needs. For, example, in the review of the programme document by CoRWM and the R&D advisory panel, we received conflicting comments about the need for R&D on colloids. We have since held an independently facilitated workshop, which was attended by a range of experts, the Chair of the R&D advisory panel and an observer from the Environment Agency. The record of the meeting will be published in the near future, setting out the views of those at the workshop on the need for R&D on colloids.

Another opportunity for dialogue on the R&D programme will be at a meeting that the Royal Society of Chemistry is hosting in October at Loughborough University. (Current status of science and technology underpinning geological disposal of higher activity wastes, 18th-20th October 2011.)

9. *Referencing is patchy. It is not clear how the summary statements in each area have been derived.*

We explain that our assessment is informed by our understanding of the research carried out by ourselves and others as well as our understanding of regulatory requirements and the views of stakeholders. We deliberately kept a light-touch in citing references, because we wanted to direct readers to the status reports [2, 3, 4, 5, 6, 7, 8, 9] in the first instance, since these give an overview of the current understanding and provide a route map to the important references from which many of our judgements have been drawn.

We appreciate that stakeholders want to be able to access our documents. To enable this:

- Many of our more frequently requested documents are down-loadable from our web-site. We are open to suggestions about which documents we should make available in this way.
- There is a searchable bibliography on our web-site and anyone can request documents to be sent to them.
- We are reviewing our approach to providing access to our documents and the best way to do this.

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10. More discrimination to prioritise between research areas would be helpful. Too many are medium. Could Technical readiness levels (TRL's) be used?

It is our opinion that the approach that we have developed is fit for purpose and gives us sufficient information to support our decision making. We did initially explore the use of Technical readiness levels (as described in the R&D strategy [10]), as these are widely used within NDA. However, we found that they were not particularly helpful at this early stage in the MRWS site selection process and we developed an approach based on 7 structured questions instead. We need to do work on a wide range of topics and we need to ensure that we have the right kind of information at the right time. The approach we have developed helps us do this.

11. Professor Haszeldine's analysis of importance of topics.

We have considered the analysis put forward by Professor Haszeldine and have the following comments:

- We feel it isn't constructive to consider whether, for example, the geosphere or the near field is more important, since we need to do R&D on both. Therefore, we don't think it is useful to compare importance at the topic level.
- Counting the total number of highs in impact, knowledge gap and urgency all together, is not comparing like with like.
- We do not agree with the methodology used to rank the "NDA perception of importance" within the review and do not agree with the use of the term "terminal". Our assessment of the impact, knowledge gap and urgency of each topic area was not intended to be used in this way. In scheduling our R&D programme, we focus firstly on the high urgency tasks. We then use the structured process to identify when to undertake the proposed R&D categorised as medium urgency. The various topic areas will not require the same level of effort. In some cases we may be able to make significant progress by undertaking a desk-based study; in others experimental work will be required.

12. Importance varies compared with that of other organisations.

A range of views on the rating of different topics is probably to be expected and we welcome the debate. As well as discussing the ratings, we would also be interested to know if stakeholders have differing views about the appropriateness of the R&D we propose to do in each area. We ask for this feedback in Section 19 of the document.

13. 52 areas need to be resolved before sites can be chosen. Do all areas need to get to low before sites can be chosen?

It is not necessary for all issues to be resolved before the end of the preparatory studies phase (MRWS stages 1-4). The MRWS White Paper states: "*The UK Government believes, in the light of CoRWM's work and wider international experience, that there is already sufficient research work available to be confident that geological disposal is technically achievable. In line with CoRWM's recommendation 4 and responses to the MRWS consultation, the NDA will undertake further research during the geological disposal facility development process in order to refine concepts, improve understanding of chemical and physical interactions in a disposal facility, address specific issues raised by regulators, support development of site-specific safety cases and to optimise facility design and delivery.*"

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Research and development will continue throughout the project and there are limitations to the R&D that we can carry out in the preparatory studies phase. In Table 1 of the R&D Programme Overview document, we set out our criteria for allocating priorities for R&D during the preparatory studies phase. We assess the urgency as high, medium or low.

High - should be progressed during the preparatory studies phase

Medium - could be progressed during the preparatory studies phase and there would be benefit in doing so

Low – need not be started during the preparatory studies phase, or cannot be started during the preparatory studies phase, given the current position in the programme.

Our R&D needs will change when we move to the next phase of the programme. Some R&D needs currently assessed as low urgency will become more urgent when we have site-specific data.

14. No costs for the work.

It was not the intention of the R&D programme document to provide information on costs. The R&D programme is needs-driven and not developed to meet a particular budget. The cost of carrying out the R&D will be determined through a competitive procurement process and it is inappropriate to set out funding arrangements ahead of this process.

15. No timescales for the work. Some issues have already been researched for long periods.

This document focuses on the R&D required in the preparatory studies phase. When we considered the timescales required for the work (see page 20), we considered times of

- Up to 1 year
- 1-3 years
- 3-5 years
- 5-10 years

It is likely that many topic areas will require further research in future phases of the programme, when site-specific information becomes available. It is important to recognise that R&D will continue throughout the MRWS site selection process and that not all issues can be or need to be resolved at the end of this phase.

16. Benefit of external scrutiny.

We agree that external scrutiny is beneficial and important. However, the specific example quoted (gaseous Carbon-14) has long been recognised in the R&D programme [11,12]

17. Under-recognition of work on gas.

We agree that gas is important. It was long been recognised as such (for example in [11]) and gas is one of our 15 R&D topics. Many of the areas within the topic are allocated a high urgency. Some of the work (e.g. on gas migration) is very site specific, but we are building our capability in preparation for when site specific information is available.

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18. Modelling – natural systems, do not provide unique answers

Our R&D on the development of total system models and the treatment of uncertainty is discussed under topic 13. We agree that models in a natural world do not have a single end point and can be used to help investigate processes and, we would add that, numerical models are only one component of the environmental safety case for a geological disposal system. Our approach to assessing safety is to understand and illustrate the range of possible behaviours of the disposal system, and the ways in which it may evolve, and to build confidence in that understanding. The treatment of uncertainty is an area of active research for a wide range of applications and is discussed in section 13.4.1. Managing uncertainty is also discussed in the Guidance on Requirements for Authorisation [13], which is one of the key regulatory documents addressed by the environmental safety case.

19. Ocean leakage

The impact of potential marine discharges in thousands to hundreds of thousands of years' time would need to be considered as part of the process of authorising a geological disposal facility and would need to consider the UK's international commitments at that time.

The UK's commitment under OSPAR is to reduce discharges, emissions and losses so that any additional concentration in the environment above historic levels is close to zero for non-naturally occurring radionuclides by 2020, taking account of:

- Legitimate uses of the sea
- Technical feasibility
- Radiological impacts to man and biota

NDA will meet all legal and regulatory requirements that apply, and these will be part of the authorisation process.

20. Repositories outside the UK

UK Government policy is that the siting of a geological disposal facility will be based on a voluntarism and partnership approach [14]. Disposal in repositories outside of the UK is not an option that is currently being considered and is beyond the remit of our R&D programme. At present, no major nuclear nation is proposing to open their facilities to international wastes.

21. Under-recognition of work on MoX and Pu.

Our R&D on the evolution of prospective plutonium wastefoms is discussed in section 4.3.1. Government is currently consulting on the long-term management of UK owned separated civil plutonium [15]. One approach to the management of plutonium is reuse in mixed oxide fuel.

In the current stage of the programme, we are assessing the durability and potential loading of various plutonium wastefoms using existing published data and scoping calculations in order to see whether any release of radionuclides from such wastefoms is likely to be significant for performance assessments. We are also performing a data elicitation exercise to evaluate the ranges of dissolution rates for potential wastefoms for plutonium to inform post-closure performance assessment models. Other relevant work is planned in the criticality safety research topic. We are not carrying out specific research on MOX, but RWMD is reviewing considerations for the disposability of spent MOX fuel through the Letter of Compliance disposability assessment process. We will re-evaluate the need for specific R&D in this area at an appropriate point following the consultation.

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22. Mox and Pu – land surface uplift

The impact of thermal processes on the geosphere is covered in section 7.2.1. We agree that it is important to consider thermal aspects in the specification, design and safety assessment of a geological disposal facility.

On the specific reference quoted by Professor Haszeldine [16], we would point out that the paper states that the assumed thermal dilation coefficient is a pessimistic assumption. Using this pessimistic value, there is a maximum uplift of 0.85m after 3000 years calculated in the centre of the uplift bend. The paper also stated that “*the radius of the uplift bend is roughly 700 km, therefore no damage is expected on infrastructures or buildings at ground surface.*” The conclusions from a more recent, as yet unpublished, Nagra report, using less pessimistic assumptions, are that the induced vertical displacement could reach up to 10 cm at the surface after 10,000 years.

In future we would use site-specific information to inform the concept design. We would set a specification for the maximum temperature in the engineered barriers and in the host rock and then develop a design to meet this specification (which for some wastes may require a cooling period prior to disposal or a minimum spacing between packages).

23. Underground research laboratories (URLs)

We agree that it will be important to do site specific underground research at a future stage (Stage 6 of the MRWS site selection process). However, this document is focused on the preparatory studies phase (up to the end of Stage 4 of the MRWS site selection process). We will develop our strategy for carrying out site specific underground research over the next few years.

24. Not taking into account lessons learnt from previous UK site investigation.

The MRWS site selection process is based on voluntarism and it is not appropriate to consider site specific information from previous site selection processes at this stage.

25. Need for funding of independent research / requirement to fund challengers.

As outlined in the MRWS White Paper, there is an engagement package that forms part of the voluntarism and partnership approach. The Partnership and any future Community Siting Partnership(s) can use the engagement package to seek the support of technical experts, including seeking independent views on research.

Communities will also have a voice when the EA receives an application, as it is part of the EA's process to consult at this point.

Other potential sources of independent funding include the Research Councils and the EU. An example of work funded through this route includes the BIGRAD consortium, which the Natural Environment Research Council has awarded £3.5 million to study the biogeochemistry and radionuclide behaviour in the region adjacent to an intermediate level radioactive waste disposal facility.

We are committed to the peer review and scrutiny of our work. Most of our R&D is externally peer reviewed. There is scrutiny of our programme by regulators, by CoRWM and by our R&D advisory panel and funding is also available through the engagement package for the Partnership to commission independent reviews.

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26. Relevance to West Cumbria. West Cumbria does not meet international norms for radioactive waste storage sites.

This is outside of the scope of the R&D programme document. The West Cumbria MRWS partnership has already asked NDA for further information on this topic and NDA is preparing a note for discussion at a future partnership meeting.

3 Summary

We welcome Professor Haszeldine's review of our R&D Programme overview. We will use Professor Haszeldine's review as an input to the dialogue that we have with stakeholders about our R&D programme and this will inform our future identification and prioritisation of our R&D needs.

Not Protectively Marked

References

- 1 Nuclear Decommissioning Authority, *Geological Disposal: Steps towards implementation*, NDA Report NDA/RWMD/013, 2010.
- 2 Nuclear Decommissioning Authority, *Geological Disposal: Package evolution status report*, NDA/RWMD/031, 2010.
- 3 Nuclear Decommissioning Authority, *Geological Disposal: Near-field evolution status report*, NDA/RWMD/033, 2010.
- 4 Nuclear Decommissioning Authority, *Geological Disposal: Geosphere status report*, NDA/RWMD/035, 2010.
- 5 Nuclear Decommissioning Authority, *Geological Disposal: Biosphere status report*, NDA/RWMD/036, 2010.
- 6 Nuclear Decommissioning Authority, *Geological Disposal: Radionuclide behaviour status report*, NDA/RWMD/034, 2010.
- 7 Nuclear Decommissioning Authority, *Geological Disposal: Gas status report*, NDA/RWMD/037, 2010.
- 8 Nuclear Decommissioning Authority, *Geological Disposal: Criticality safety status report*, NDA/RWMD/038, 2010.
- 9 Nuclear Decommissioning Authority, *Geological Disposal: Waste package accident performance status report*, NDA/RWMD/032, 2010.
- 10 Nuclear Decommissioning Authority, *The NDA's Research and Development Strategy to Underpin Geological Disposal of the United Kingdom's Higher-activity Radioactive Wastes*, NDA/RWMD/011 – issue 1, March 2009.
- 11 United Kingdom Nirex Limited, *The viability of a phased geological repository concept for the long-term management of the UK's radioactive waste*, Nirex Report N/122, November 2005.
- 12 United Kingdom Nirex Limited, *C-14 How we are addressing the issues*, Nirex technical note, 2006.
- 13 Environment Agency, *Geological Disposal Facilities on Land for Solid radioactive Wastes: Guidanec on Requirements for Authorisation*, February 2009.
- 14 Defra, BERR, Welsh Assembly Government, Department of the Environment Northern Ireland, *Managing Radioactive Waste Safely: A Framework for Implementing Geological Disposal*, Cm7386, June 2008. ISBN 0101738625.
- 15 Department of Energy and Climate Change, *Management of the UK's Plutonium Stocks*, February 2011.
- 16 Klubertanz et al, *Impact of the thermal load on the far field and galleries of a HLW Repository*, Physics and Chemistry of the Earth, 33, S457-S461, 2008.