RETRIEVABILITY AND DESIGN OF A GEOLOGICAL REPOSITORY

NuLeAF
NUCLEAR LEGACY ADVISORY FORUM

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Introduction

This Briefing Paper has been prepared to inform discussion of the respective merits of early closure of a geological repository, compared with a period of extended underground storage prior to closure.

It covers:

- Definition of terms
- Repository design concepts
- The pros and cons of designing for reversibility
- International experience
- A note on monitoring
- Addressing repository design during the siting process

Definition of Terms

The term 'retrievability' is often used as a short-hand for a number of different ways of getting radioactive wastes out of a repository. To promote better understanding, it is helpful to distinguish between three terms:

- Reversibility – where the waste can be taken out of a repository by simply reversing the original emplacement process. In this case, the repository is functioning as a store and all backfilling is delayed.
- Retrievability – where the waste can be removed because access tunnels have not been sealed and the material used to 'backfill' vaults can be removed, for example, by water jetting.
- Recoverability – where the waste can only be removed by mining or similar intrusive methods. In this case, the whole repository has been back-filled and sealed.

With these definitions, 'retrievability' has a much more specific and narrow meaning than normally understood. It is arguable that when many stakeholders refer to the need for 'retrievability' they are actually referring to a preference for 'reversibility', rather than for 'retrievability' or 'recoverability' as defined above.

Repository Design Concepts

Prior to the CoRWM process, Nirex developed a Phased Geological Disposal (PGD) concept intended to allow 'reversibility' over a period up to a few hundred years ie for an extended period of underground storage prior to backfilling and sealing the repository. This concept involves a design that would enable the repository to remain open for that time. The design

is intended to ensure that: vaults can be left open; on-going maintenance and refurbishment could take place; and atmospheric conditions in the repository could be controlled to preserve the integrity of waste packages for as long as possible.

Alternatively, a repository can be designed for backfilling and closure as soon as all wastes have been emplaced. The design and geological requirements for such a repository would be somewhat less onerous than for PGD[1].

The Pros and Cons of Designing for Reversibility

CoRWM's public and stakeholder engagement programmes showed that many citizens and stakeholders support the idea of being able to have an extended period of underground storage prior to repository back-filling and closure:

> … people generally support a management strategy aimed at reducing burdens on future generations while at the same time presenting sufficient flexibility to address concerns about public confidence and enable retrievability in response to future technological advance or new information about risks and opportunities.[2]

CoRWM, however, took the view that leaving a repository open, for centuries after waste emplacement, increases the risks disproportionately to any gains. Government has recently endorsed this view[3].

The pros and cons that need to be taken into account in reaching a judgement about whether to design a repository for an extended period of underground storage prior to closure are as follows[4]:

Pros

Wastes could be taken out of the repository in response to:

- Technical safety concerns that are only recognised after waste emplacement eg advances in scientific understanding reveal unexpected characteristics or phenomena that are detrimental to the long-term safety of the repository.
- A desire to extract resources from the wastes in the repository.
- A desire to use alternative waste treatment or disposal techniques developed in the future.
- Changes in social acceptance and perceptions of risk, or changed policy requirements.

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[1] CoRWM notes that the "these differences in design are regarded as a matter of detail" by many experts (report to Government, July 06, p117). Making provision for an extended period of reversibility is less challenging in hard rocks than clay or salt.

[2] CoRWM Report to Government, July 2006, p119-120.

[3] 'Managing Radioactive Waste Safely: A Framework for Implementing Geological Disposal', Consultation Document, 25 June 2007, para 3.19.

[4] This review of pros and cons draws on discussions during the CoRWM process and an overview in NEA, Considering Reversability and Retrievability in Geologic Disposal of Radioactive Waste, OECD, 2001

Other pros include:

• Flexibility (the repository could be backfilled and closed at any time within the design life for the period of extended underground storage).

• Public and stakeholder support, increased prospect of acceptability to potential host communities, and potential to inspire more confidence.

On the latter, Nirex have argued that a period of extended underground storage could enable increased confidence to be developed through the provision of consistent monitoring information and continued scrutiny of the long-term safety case[5].

Cons

- Reasons for not keeping a repository open for extended periods include:
- Imposing burdens on future generations, including the need for continued active management of the wastes during underground storage, and ultimately the need to backfill and close the repository or retrieve the wastes.
- Potential negative effects, including conventional safety and radiological exposure of workers engaged in extended storage operations.
- Potential for failure to seal a repository properly due to loss of organisational, technical or financial capabilities.
- Increased opportunity for unauthorised access to the repository to retrieve or interfere with the wastes during times of social or political unrest.

Other cons include:

- Increased financial costs associated with more onerous design requirements and keeping the repository open for longer.
- Questionable flexibility – once wastes are emplaced it is difficult to envisage circumstances where wastes would be removed, because this would require alternative facilities and potentially involve abandonment of an expensive repository.

In addition, an Environment Agency review of the viability of Nirex's PGD concept[6] has expressed concern that plans for a long period of underground storage are not sufficiently technically underpinned. The EA expressed particular concern about waste package degradation during extended storage. In response, Nirex argued that if packages are stored under suitable conditions and handled appropriately they are not expected to require repackaging within a period of 300 years[7]. CoRWM took the view that this period might be shorter and that there is a need for greater clarity about anticipated package lifetimes.

International Experience

In a review of retrievability concepts for CoRWM, Wardell Armstrong report[8] that out of 14 repository programmes worldwide:

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[5] Nirex, 'Context Note: Retrievability', Document for CoRWM, December 2005.

[6] EA, 'Review of Nirex Report: The Viability of a Phased Geological Repository Concept for the Long-Term Management of the UK's Radioactive Waste', NWAT/Nirex/05/003, November 2005.

[7] Nirex, 'Context Note: Retrievability', Document for CoRWM, December 2005.

[8] Wardell Armstrong, 'Deep Disposal – Concepts of Retrievability and the Views of Stakeholders', TS042, October 2004.

- 8 include reversibility in the design concept for a period beyond the emplacement of wastes
- 1 includes it only for the period of operation of the repository
- 3 have not yet decided and
- 2 make no provision for reversibility.

They also point out that from an international perspective "opinions that stakeholders, especially the public, generally require the inclusion of retrievability within the design concept are widespread".

Monitoring

The issue of monitoring is often considered alongside that of reversibility. CoRWM reported that the Nirex PGD concept includes a period of monitoring conditions in a repository before and after vaults are backfilled. It noted that the concept only provides for sub-surface monitoring over a few hundred years, but that surface based monitoring would be possible for as long as there is institutional control. The Environment Agency is understood to take the view that post-closure monitoring will not be required for a repository that has an adequate safety case.

Addressing Repository Design During Repository Siting

NuLeAF's Policy Statement on Geological Disposal[9] noted that a final decision on repository design is not needed until underground investigations have begun, which allows time for further research, discussion and agreement with potential host communities and others on repository design features. This position accords with that of CoRWM:

> .. it is unlikely that underground investigations will start for at least 15-20 years, and a decision on the detailed repository design will not be needed until then. There are already several different repository concepts designed to allow for monitoring and possible retrieval before final closure and it is likely that thinking in this area will develop further. The delay before site investigations begin will allow time for further research, discussion and agreement with potential host communities and others on the design features that should be included.

More recently, Government has stated that the design and construction of a repository "can be carried out in such a way that option of extended retrievability is not excluded"[10].

NuLeAF considers that the issue of whether to design a repository for an extended period of reversibility should be discussed and agreed with potential host communities during the siting process.

[9] NuLeAF, 'Geological Disposal', Policy Statement 3, January 2007.
[10] 'Managing Radioactive Waste Safely: A Framework for Implementing Geological Disposal', Consultation Document, 25 June 2007, para 3.20.