MEASURES TO ENHANCE THE RETRIEVABILITY OF WASTES FROM A GEOLOGICAL REPOSITORY

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Introduction

This Briefing Paper outlines the measures that can be used to enhance the retrievability of radioactive wastes from a geological repository. The purpose is to promote an understanding of how retrievability can be achieved in practice, and how it is likely to change over time. This should help potential host communities reach judgements about the extent to which future proposals from the Nuclear Decommissioning Authority (NDA) are likely to meet their aspirations for retrievability.

The paper is the second NuLeAF Briefing Paper on retrievability. The first, Briefing Paper F (BPF), reviewed the pros and cons of putting in place measures to enhance retrievability[1]. It concluded that the extent to which such measures should be put in place should be discussed with, and agreed by, potential host communities during the siting process.

This Briefing Paper should be read in conjunction with the review of pros and cons in BPF, and the NuLeAF Policy Statement on geological disposal[2]. The current paper covers:

- Definition of terms
- Measures to enhance retrievability
- Retrievability in the Phased Geological Repository Concept
- International practice
- Concluding remarks

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 avoid confusion about what is really meant, it is helpful to distinguish between:

[1] NuLeAF Briefing Paper F ('Retrievability and Design of a Geological Repository', July 07)

[2] NuLeAF Policy Statement 3 ('Geological Disposal', January 07)

- Reversibility – where the waste can be taken out of a repository by simply reversing the original emplacement process. In this case, the repository has not been back-filled and sealed.
- Recoverability – where additional steps have to be taken to retrieve the wastes. If access tunnels have been kept open, this might entail removing the material used to 'backfill' vaults, for example, by water jetting. However, if access tunnels have been back-filled, it would entail mining or similar intrusive methods.

In all these cases, the waste is 'retrievable', but the cost and complexity of retrieval increases as we go from „reversibility" through more difficult types of „recoverability". In other words, the retrievability of the wastes decreases. It is arguable that when stakeholders refer to the need for retrievability' they are often expressing a desire for „reversibility", where the waste can be taken out of the repository without having to remove back-fill material, or use expensive mining methods.

It should be noted that the idea of reversibility can also be applied to the decision-making process during siting. In this case, the term applies to steps in the siting process, where decisions can be reconsidered and reversed if necessary. When people refer to reversibility, therefore, it is important to be clear about whether reference is being made to steps in the siting process, or the design and operation of the repository. This Briefing Paper focuses on the latter.

It is also worth reflecting on the implications of the definitions of the terms 'disposal' and 'storage'. In the context of a geological repository, disposal means emplacement of wastes with no intent to retrieve. In contrast, storage means emplacement with intent to retrieve. The primary distinction, therefore, between disposal and storage, is whether or not there is an intention to retrieve the waste at some later point. When a geological repository is designed so that the wastes can, for a period of time, be taken out by reversing the emplacement process, strictly speaking this does not mean the wastes will be in 'storage' because there is no actual intent to retrieve the wastes, but a capability to do so, if the need or desire arises. Nonetheless, the term storage is often applied to the period when wastes could be retrieved by simply reversing the emplacement process.

Measures to Enhance Retrievability

According to a 2005 study within the ESDRED programme of the European Union[3], these measures fall into the following design and operational categories:

- Design of the repository – retrievability would be enhanced through improved stability of access tunnels and shafts and disposal vaults, a reduced number

[3] ESDRED Review of Measures for Retrievability (BRW Haverkate, May 05)

of packages per vault, control of environmental conditions in the vaults, reduced distance from emplaced wastes to the nearest access point, enhanced stiffness and water tightness of vault lining and use of easily removable backfill material.

- Design of the waste packages – retrievability would be enhanced by good corrosion resistance of the package material and emplacement of packages in disposal containers or over-packs.
- Operational measures – retrievability would be enhanced by keeping disposal vaults, access tunnels and access shafts open.
- Monitoring of package integrity – retrievability would be enhanced by maintaining package integrity. To do this, requires monitoring of temperature, water saturation and geochemistry in the disposal vault.
- Monitoring of waste accessibility – retrievability would be enhanced by maintaining waste accessibility. To do this, requires monitoring of the stability of openings, the extent of water saturation in back-filled vaults, and ambient conditions (eg temperature and radiation) in the repository.
- Maintaining equipment – retrievability would be enhanced by maintaining or replacing equipment installed to allow reversibility of waste emplacement (eg lifting gear).

Retrievability in the Phased Geological Repository Concept

Prior to its integration into the NDA, Nirex had developed a Phased Geological Repository Concept (PGRC) intended to allow wastes to be retrievable until a decision is taken to close the repository[4]. Nirex considered that in principle the repository could be kept open over hundreds of years. It explained that the following features would allow an extended period of retrievability:

Vault stability and integrity	• Vaults constructed in good quality, strong crystalline rock[5] • Integrated rock support system (rock bolts and sprayed concrete) • Shafts and access ways constructed to ensure sustained stability
Waste package stability and stability of stacks	• Use of stainless steel drums or boxes (ILW) • Stack heights calculated to ensure stability
In-vault equipment operability	• High degree of removable equipment for maintenance • All emplacement equipment specified to be capable of use in reverse mode • Unshielded ILW emplaced by overhead crane allowing more convenient access to individual packages

[4] Nirex Technical Note on Retrievability (Note 484424, December 05). 5 The Nirex note explains that it would be necessary to conduct site specific studies to develop understanding of the level of retrievability that could be applied to a specific geology.

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Groundwater management	• Vaults constructed in low permeability rocks • Incoming groundwater diverted away from the waste by engineered drainage systems
Vault environment control	• Ventilation fans and filters and air conditioning equipment sited outside the vaults • Controls of temperature, humidity and chloride levels to minimise package corrosion
Records, maintenance and monitoring schedules	• Records kept of locations of consignments and packages within the vaults • Programme of monitoring and testing

For Nirex, the design philosophy of the PGRC provided flexibility by offering options for continued maintenance and refurbishment of the repository. They highlighted that this would enable future generations to extend the period of 'underground storage', if they so wished, while retaining the option for retrieval, or to seal and close the repository.

It should be noted, however, that the Environment Agency expressed some concerns that the "plans for a long period of storage, which is envisaged as part of the Phased Geological Repository Concept, are not sufficiently underpinned technically"[6]. The technical limitations on the period of 'underground storage' will be an important issue for review and discussion during the siting process.

International Practice

The ESDRED review shows that there are a wide range of national requirements for retrievability. However, it highlights that most national disposal concepts aim to show that waste could be retrieved during the operational period of a repository, but only limited provisions are intentionally incorporated in the design of the repository to facilitate easy retrieval of the waste. The review also points out that in most countries pursuing geological disposal these issues are still under consideration and definite positions are unlikely to be reached until much closer to the start of the development phase of a repository.

Examples of the limited measures under consideration in specific countries are:

- Belgium – Spent fuel and high level waste to be placed in overpacks before emplacement in 'supercontainers' incorporating buffer material.
- France – Spent fuel vaults to be steel lined and other openings to be lined with concrete. SF and HLW to be placed in overpacks. Clearance to be maintained between packages and vault lining.

[6] Environment Agency, „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.

- Netherlands – Openings designed for access for more than 100 years, one package per disposal cell, over-pack or lining.
- Spain – Use of liners and pre-fabricated bentonite back-fill.

In addition to the ESDRED review (2005), useful discussion of international practices can be found in the proceedings of an IAEA symposium on retrievability[7], and in a report commissioned by CoRWM8. Concluding Remarks Judgements about the extent to which measures should be taken to enhance the retrievability of radioactive wastes from a geological repository should be based on what is technically achievable, and involve a careful weighing of the pros and cons.

This Briefing Paper has provided an outline of the technical approaches that are being considered to enhance retrievability. These are often intended to increase the period of time over which wastes can be retrieved by reversing the processes used to emplace them in the repository. Compared to other countries, the former Nirex"s intention to ensure reversibility, if desired, for up to several hundred years was relatively ambitious.

[7] IAEA Techdoc 1187 („Retrievability of High Level Waste and Spent Nuclear Fuel", IAEA Tecdoc 1187, Dec 2000). 8 Wardell Armstrong