



CoRWM Position Paper: Retrievability Considerations for Geological Disposal

15th November 2018

This Position Paper reflects the Committee on Radioactive Waste Management's (CoRWM) current position on retrievability considerations for geological disposal of radioactive waste. The paper will be updated and revised when more information becomes available.

1. Introduction

CoRWM Position Paper 3522 summarises the work that led CoRWM to recommend geological disposal for the long term management of higher activity radioactive waste rather than indefinite storage and confirms that CoRWM is not aware of any analysis and experience that would change this opinion.

One aspect of geological disposal which has been debated frequently during discussions on a geological disposal facility (GDF) is whether and if so what provision should be made for retrieval of the waste from the GDF if circumstances change after the emplacement of the waste. This is often couched in terms of '*weaknesses being found in the safety of the repository requiring recovery*' but has also covered '*changes in economics leading to the emplaced waste having a positive value*'.

The 2006 paper '*CoRWM's Managing Radioactive Waste Safely: CoRWM's Recommendations to Government*' (CoRWM doc. 700)¹ involved a very weighty consideration of the merits and demerits of retrievability. Unlike other matters on which it reached a conclusion, CoRWM produced a balanced assessment of the retrievability option but left these considerations for future decision makers. A search of literature from 2006 to the present confirms this balanced position, and while there are very firm opinions on all sides, there is no current policy presumption on the implementation or otherwise of retrievability options.

In this Position Paper, CoRWM has therefore reviewed and reported the arguments presented in the 2006 paper and looked for any developments in the intervening years which could have led it to modify its position.

2. Disposal and Retrievability

CoRWM Doc. 700 was firm in its recommendations on the meaning it ascribed to the 'disposal', as shown below (page 13 of the Report):

Recommendation 1: Within the present state of knowledge, CoRWM considers geological disposal to be the best available approach for the long-term management of all the material*

¹ Managing our Radioactive Waste Safely, CoRWM's Recommendations to Government, Doc 700, July 2006

categorised as waste in the CoRWM inventory² when compared with the risks associated with other methods of management. The aim should be to progress to disposal as soon as practicable, consistent with developing and maintaining public and stakeholder confidence.

**“Disposal” in the context of CoRWM’s recommendations on geological disposal means the burial underground (200 – 1000m) of radioactive waste in a purpose-built facility with no intention to retrieve the waste once the facility is closed.*

However, various types of retrieval were examined and three levels were defined³:

- a. reversibility – designed into the option to facilitate the recovery of material by reversing the original emplacement process
- b. retrievability – designed into the option to facilitate the physical retrieval of waste through means other than reversing the process, such as ensuring access to the waste and having (or being able to have) the retrieval mechanism in place
- c. recoverability – addressing the retrievability issue by demonstrating that the waste is technically recoverable through mining or other means.

This is seen to cover the spectrum from ‘*emplacing the waste, then prompt removal by the same route*’, to ‘*retrieval of long-emplaced waste by mining or its equivalent*’. It has been thought worthwhile to reproduce this section of the Report, which is attached as Appendix 1.

3. Retrievability – Why? Why not?

Considered as an ethical problem, the choice of retrievability may be characterised as an interplay between two basic viewpoints as defined in CoRWM Paper 600⁴:

Deal with it Now: *This position broadly reflects ethical considerations of justice arising from the belief that those who benefit should bear the burden. It emphasises the responsibility of the present generation to do what it can as soon as it can so that the transfer of burdens to following generations can be minimised. This position tends to favour geological disposal placing no reliance on the ability or willingness of future generations to deal with a problem created by the present.*

Leave it until Later. *By contrast, this approach emphasises the principle of liberty, providing the future with the freedom to make its own choices. This comes from a position which recognises both the rights of future generations as well as the responsibilities of the present. It is incumbent on the present to provide information and compensation to enable the future to take responsibility. This view tends to favour continuing storage options with the possibility of retrievability.*

Notably, neither of these extremes can be said to be ‘right’ or ‘wrong’, they depend on the values held by the stakeholders and were extensively examined in the Multi-Attribute Decision Analysis (MADA) process which was carried out by CoRWM and underlay many of its conclusions. The dilemma can be described as a trade-off between minimising burden (emplace waste and prompt backfill/closure) and increasing flexibility (delay backfill/closure, keep options open) that became one of the most significant discriminating options in the MADA.

² The CoRWM Inventory is defined and discussed in Annex 3 of CoRWM Doc 700, July 2006

³ CoRWM Doc. 700, Page 117. *Retrievability and Monitoring, paragraph 8*

⁴ CoRWM Doc. 700, page 40

This MADA process was supported by very extensive stakeholder consultation, including information from the public gained by Citizen's Panels, a Discussion Guide and a Schools Project. These will not be further detailed here, but merit study and are fully described in Paper 700.

Notably, all options were underlain by the need to maximise safety in the '*here and now*', and prompt action to achieve safe storage for all wastes was practically universally supported. This is emphasised by Recommendation 2 from Paper 700, as seen below:

Recommendation 2: A robust programme of interim storage must play an integral part in the long-term management strategy. The uncertainties surrounding the implementation of geological disposal, including social and ethical concerns, lead CoRWM to recommend a continued commitment to the safe and secure management of wastes that is robust against the risk of delay or failure in the repository programme.

Thus CoRWM was (and is) firmly for prompt action on both disposal '*The aim should be to progress to disposal as soon as practicable, consistent with developing and maintaining public and stakeholder confidence*' (see Recommendation 1 above), and for robust action on interim storage. It is only the degree of possible retrievability on which it takes a balanced approach.

Though not so characterised in Paper 700, the '*Deal with it now*' and '*Leave it until later*' can be viewed as representing the spread from '*the science is firm and we can make a commitment now*' to '*the science might change so we need to keep options open*'. This also mirrors the fact that, while many stakeholders are willing to agree that a proper safety case for a GDF will ensure long term safety, there are many who do not believe that the science involved is well enough developed to provide assurance over the extremely long timescales involved. Such considerations emphasise that, while a policy decision will in due course be made, there is no chance that this can ever meet with universal stakeholder approval.

4. Retrievability – Decision Making

There is little doubt that CoRWM's equivocal stance on retrievability in 2006 was due to the fact that any practical effects of a '*degree of retrievability*' decision would only become clear years or decades into the future. The practical challenges of retrievability will vary greatly with host rocks chosen for the GDF. The issues to consider can be summarised as follows:

- Retrievability would generally require underground excavations for access to remain open and stable for a long period of time, in the order of decades. This would mean that such longer-term design lives will have to be incorporated into the initial specifications and plans.
- Equipment would have to be available until the retrievability issue becomes settled. This would require comprehensive maintenance schemes to be in place. Very long inactive periods would have to be incorporated in the initial equipment specifications.
- The guarantee of both access and operationally available equipment will necessitate the design, implementation and maintenance of major monitoring schemes and infrastructure during the construction, operation and post-operational phases.
- It is probable that additional excavations will have to be made as a contingency for major failures that may occur.
- The requirements for remote operation in radiologically hazardous areas will need to be determined.
- The effect of delaying backfill and the impact of the geology, the groundwater regime and the waste packaging involved will need to be determined.
- The likely impact on overall costs of providing a reasonably certain outcome on retrievability will also be very significant.

As an overall consideration, reversibility by definition requires that all emplacement infrastructure (access galleries, vaults, handling equipment etc etc) are maintained in operational condition. Even in hard rock hosts this may be challenging over long time scales and thus be costly.

This should make the consideration of retrievability a significant part of working with volunteer communities, from the viewpoint of clarifying the engineering/cost/timescales involved and, during the development of this knowledge, obtaining and understanding stakeholder views. To judge from stakeholder reactions in 2006, it is inevitable that stakeholders will raise these questions on retrievability, and it would be prudent to design these considerations into the process. It may also be useful to consider the nature of perceptions here and address how leadership and provision of information and responses to their concerns might shape a community's settled will, or at least their perception and confidence at the point of decision making.

5. Conclusions

A study of the 2006 CoRWM process makes clear that the issue of retrievability will be a significant concern for communities involved in the siting process. It will be prudent to consider during the siting process how debates that may take place on retrievability can be informed by the available evidence so that the best available answers can be given to stakeholder queries as the knowledge of any potential GDF volunteer site develops.

Appendix 1. CoRWM Paper 700, Page 117. Retrievability and monitoring

8. CoRWM devoted considerable time to a discussion of retrievability in order to identify the possible reasons why waste might need to be retrieved, or ought not be retrieved, and to assess the extent to which options, in practice, allowed retrievability. The term 'retrievability' is used as a short-hand for a number of different ways of getting the waste out. At its simplest, the waste could be removed by reversing the original emplacement process. This form of retrievability, which CoRWM describes as reversibility, could be provided by storage facilities, for example. Under some repository design concepts, it would be possible to withdraw the waste by building in a methodology that would allow access to the waste even after vaults had been backfilled; for example by keeping access tunnels open for a period after emplacement and ensuring that the backfill could be removed. CoRWM describes this as retrievability. In addition to the 'built-in retrievability' offered by these methods of removing the waste, CoRWM identified a third category, recoverability in which waste is recovered from a repository by mining or similar intrusive methods. Recoverability is not part of the design specification and would be likely to pose greater technical challenges and be more expensive.

9. CoRWM found it useful to consider concepts for geological disposal from the viewpoint of the extent to which they allow for the removal of the waste. These are described as they might be applied to intermediate level waste, but similar approaches could be developed for high level waste and spent fuel. This approach categorised geological disposal in terms of four broad approaches to backfilling and sealing a geological repository:

- i. The vaults are each backfilled with grout (cement) as soon as they are full of waste. In practice, they would be backfilled in batches in order to keep the grouting process separated from the emplacement of waste in empty vaults. This approach creates a good chemical environment around the waste packages at the earliest opportunity and thus preserves the integrity of the stainless steel containers to the greatest possible extent. The removal of the grout by water jetting has been demonstrated. Thus, the waste is retrievable, in principle, until the repository as a whole is backfilled and sealed.
- ii. The first vault is backfilled when it is full of waste and the integrity of the waste packages is monitored. Backfilling of the remaining vaults is delayed until a point is reached when there is sufficient confidence to backfill the remaining vaults. This enables the monitoring of the first vault to be undertaken under conditions that represent those that will occur when all the vaults have been backfilled. Apart from the first vault, this approach provides reversibility.
- iii. None of the vaults are backfilled until all the waste is emplaced, when the whole repository is backfilled and sealed. This approach provides reversibility up until this point. In the meantime, the waste is monitored in the same way as it would be in a store.
- iv. After the waste is emplaced, the facility could function as a store and all backfilling could be delayed for up to a few hundred years (although backfilling could be carried out sooner if so desired). Nirex's phased disposal concept is an example of this approach.*

10. Clearly, then, a repository designed for phased geological disposal could also be operated so that it could deliver the other three geological disposal approaches. The main difference lies in the intention at the design phase. Phased geological disposal is intended to allow for a period of interim storage underground followed by disposal. The other approaches are intended to deliver disposal but incorporate a degree of flexibility that will permit retrievability.

11. Approach (iv) (phased geological disposal) requires the vault to remain open for a period of up to a few hundred years. Because of the need for geological stability during this period, the geological criteria may be more stringent for approach (iv) than for the others. It also requires the atmospheric conditions in the repository to be carefully controlled to preserve the integrity of the waste packages for as long as

possible and minimise the extent of repackaging. Approach (i) (early closure) requires the shortest period of maintenance of the open vaults. Approaches (ii) and (iii) lie between these two extremes but could require the vaults to be stable for the 65 years that Nirex estimate that it would take to emplace the UK's inventory of intermediate level waste².

12. If the repository is designed for approach (iv), the decision on what approach is taken can be postponed until the first vault is full. As discussed below, this is regarded as an advantage by some and a disadvantage by others, because it implies that a decision as to whether to store the waste for a long, but interim, period can be delayed for future generations to decide. If approaches (ii), (iii) or (iv) are selected, the decision on when to backfill and seal can be made at any time up to the design life of the repository. However, a decision on closure will also need to take account of the design life of the containers. CoRWM's understanding is that containers will retain their integrity for a period of about 100-150 years but there is a need for greater clarity on this point.

International Experience

13. In other countries where geological disposal has been selected as the long term management option it has been also recognised that there is a need to provide a degree of retrievability in order to meet public concerns. The challenge is to find a way of doing this without jeopardising the fundamental safety concept.

14. The Swiss concept of Monitored Geological Disposal for spent nuclear fuel involves the construction of a pilot vault alongside the main repository vault. The intention is that conditions within the pilot vault will be monitored for a period of between 50-100 years. Meanwhile, waste emplacement in the main repository vaults will proceed and individual vaults will be backfilled. This would not, however, preclude the removal of the waste should this be deemed necessary.

15. In the Scandinavian KBS-3V concept for spent nuclear fuel, the emplacement tunnels and the gallery are backfilled with clay but the main access ways and the access tunnel need not be backfilled until the repository is full. In principle, these can be kept open for several hundred years - as long as the period of storage envisaged in the Nirex phased disposal concept. The removal of the clay has been demonstrated. Thus, this concept provides retrievability until the repository is closed. It would also provide protection against misappropriation of the fuel and plutonium.

16. In the Belgian concept for HLW, the canisters are within stainless steel tubes, which need not be backfilled for some time. The tubes can be withdrawn. Thus, this concept provides a type of retrievability. It also provides some protection against misappropriation.⁵

17. The Japanese nuclear management body has developed a range of repository concepts for HLW disposal as a 'catalogue' from which the most appropriate might be selected for specific sites. The Cavern Retrievable (CARE) concept provides the maximum flexibility and ease of removal. In this concept the fuel is placed in a stable matrix in thick-walled steel casks, which are placed in vaults. Any of the four approaches outlined above can be implemented. This concept, therefore, could be used to provide either reversibility or retrievability. It provides less protection against misappropriation.

⁵ Since CoRWM Document 700 was written, it was decided by the Belgian authorities not to continue with the use of stainless-steel tubes, and a revised disposal concept involving the use of a so-called supercontainer was developed as the preferred concept for all Category C waste (Vitrified HLW and spent fuel). Supercontainers are pre-formed concrete monoliths into which waste canisters are inserted within a metallic overpack and surrounded by bentonite. These are then emplaced in the disposal tunnels. This is still considered to allow retrievability if required.

CoRWM's view

18. Many citizens and stakeholders support the concept of phased disposal. What they have said is broadly consistent with earlier messages throughout CoRWM's programme: 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 possible future technological advance or new information about risks and opportunities.

19. Others see phased disposal as a false reassurance that increases environmental, security and safety risks. There are concerns that, if a repository was left open for a period of interim storage, there would be an increased risk of release of radioactivity to the environment. There are also concerns, because of the need to maintain the facility in its storage phase, about the time period for which institutional control will be needed and that this will increase the risk to humans, including the workers who will have to maintain it for longer until it is sealed and brought to a state of "passive safety". It might also increase the vulnerability of the waste to terrorist action.

20. CoRWM's view is that leaving a repository open, for centuries after waste has been emplaced, increases the risks disproportionately to any gains.

21. Even if a form of direct geological disposal is chosen, it will be a hundred years or so before the waste is completely sealed in place and reversal or retrievability is no longer possible. This time delay may provide sufficient reassurance for those people who wish to retain the possibility of doing something else with the waste, for example, utilise better methods of waste management which have been developed in the meanwhile or because a use has been found for the 'waste'.

22. For some people, a period of monitoring the conditions within a repository is regarded as important to check that the performance of the repository in practice accords with the models forming the basis of the safety case. The Nirex concept and the Swiss concept are two examples where there is a built in period of monitoring conditions in a repository before and after vaults are backfilled. However, the concepts only provide for monitoring over a few hundred years at most, and cannot provide reassurance about repository performance in the long term, which is usually the period of greater concern because of the uncertainties over what will happen when the engineered barriers fail. Monitoring at the surface will be possible for any design of repository and it will be possible to continue this for as long as there is institutional control.