Improving Credibility and Competence in Geological Disposal through International Co-Operation and Initiatives - 14499

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ABSTRACT

Geological disposal is internationally recognised as the preferred approach for the long-term management of higher activity radioactive waste. However, despite many decades of research into geological disposal there is no operating facility for the disposal of spent nuclear fuel and the majority of higher activity wastes currently stored by many countries. The EU Waste Management Directive requires nations with an active nuclear industry to submit strategy and national programmes in 2015. Within Europe there are some programmes near to implementation and some very much in the strategy and planning stages opening up the opportunities for knowledge sharing and bi-lateral agreements between countries. This presents an opportunity for international co-operation to move the technology out of the theoretical research stage into development and demonstration in order to improve not only the technical understanding of the issues and techniques but also to improve the competence of international waste management organisations (WMOs). The WMOs need to gain the confidence of all stakeholders, including regulators and the general public that geological disposal is a credible option that can be implemented with today's technology.

INTRODUCTION

Geological disposal is internationally recognised as the preferred approach for the long-term management of higher activity radioactive waste. However, despite many decades of research into geological disposal there is no operating facility for the disposal of spent nuclear fuel and the majority of higher activity wastes currently stored by many countries. The main source of nuclear waste in Europe is from the operation of nuclear reactors. The IAEA (International Atomic Energy Authority) through the international Joint Convention [1] and associated NEA/OECD (Nuclear Energy Agency/Organisation for Economic Co-operation and Development) and European Union legal requirements state that each nation is responsible for managing the waste produced within its borders. Furthermore a European Directive was introduced in 2011 [4] requiring all member states with an active nuclear industry to submit to the European Commission a country strategy and national programme by 2015.

This Directive establishes a Community framework for ensuring responsible and safe management of spent fuel and radioactive waste to avoid imposing undue burdens on future generations. It ensures that Member States provide for appropriate national arrangements for a high level of safety in spent fuel and radioactive waste management to protect workers and the general public against the dangers arising from ionising radiation. It ensures the provision of necessary public information and participation in relation to spent fuel and radioactive waste management while having due regard to security and proprietary information issues.

The European Commission introduced technology platforms as a tool to develop a common vision and strategic research agenda with short- and medium term objectives for implementation of geological disposal. The ambition is to bring together research and

development, relevant stakeholders with various backgrounds (e.g. regulatory bodies at various geo-political levels, industry, public authorities, research institutes and the academic community, the financial world, and civil society) who would develop a research and development strategy in areas of research needed in Europe. The Implementing Geological Disposal of Radioactive Waste Technology Platform (IGD-TP) has been established as part of this initiative. Through the IGD-TP a Strategic Research Agenda (SRA) has been compiled that sets out the vision but recognises that specific arrangements will be necessary to facilitate technology transfer.

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SKB (Svensk Kärnbränslehantering, the Swedish Nuclear Fuel and Waste Management Company) is committed to supporting other countries in implementing deep geological disposal by means of transfer of technology and the experience gained from siting and stakeholder communication in Sweden. SKB International was created for this purpose and has provided support in radioactive waste management to more than 20 countries since 1984.

The NDA RWMD (Nuclear Decommissioning Authority, Radioactive Waste Management Directorate) aims to build on existing knowledge available in the UK and overseas and adapt relevant solutions to the UK situation where this knowledge appropriately meets the needs of the UK disposal system and provides benefits to the UK programme.

BACKGROUND

SKB has co-operation agreements with many countries and has carried out numerous joint projects with international involvement. As the SKB programme has progressed towards the milestone of submitting the licence applications, which was achieved in March 2011, SKB International has investigated how to assist other countries.

The challenge was firstly how to describe the SKB programme, focusing on the strengths and unique skill in terms of defining WHAT needs to be done (and WHY) and HOW the implementer might set out the approach. In its role as implementer SKB retains control and direction of the project in terms of WHAT needs to be done and armed with the examples, lessons and experiences this can be factored into the decision and description of HOW this can be done. The supply chain is then mobilized TO DO the actual works and activities. This puts the implementer in the position of intelligent customer with the ability to get the most cost effective solutions from the supply chain.

SKB is in a position to use their experience, as well as examples and lessons learned, to advise other implementers of WHAT needs to be done and HOW it can be done, such that other WMOs can strengthen their position as the intelligent customer for their Geological Disposal Facilities (GDF).

The NDA RWMD is developing its approach to technology transfer [10] and has set out the following strategic objectives:

- To improve confidence in the UK programme using evidence and demonstration that geological disposal is being implemented overseas.
- To optimise the duration of the implementation programme and minimise programme risk.
- To deliver value for money, factoring affordability into assessments of the cost effectiveness of technology transfer.

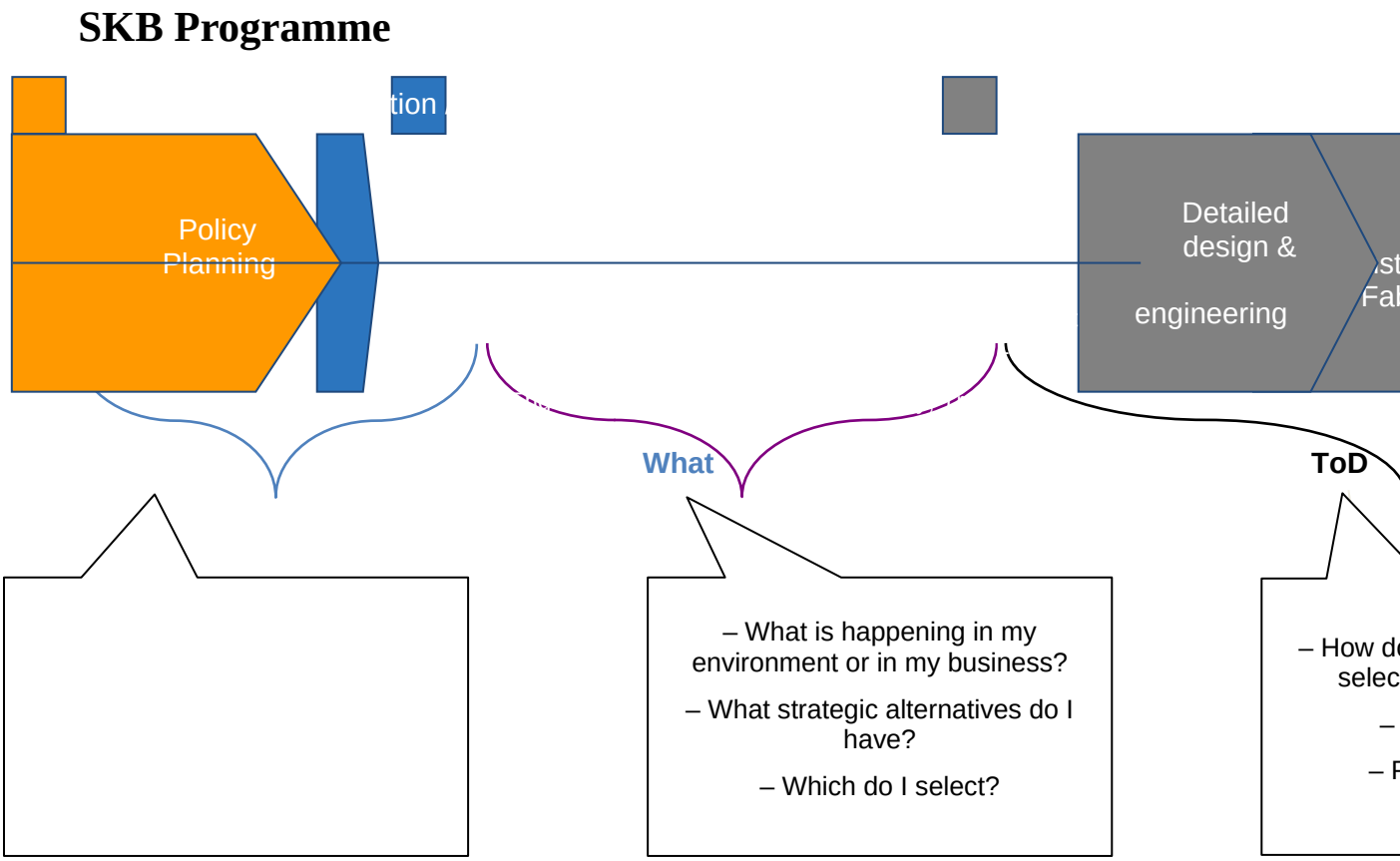

Figure 1 SKB Programme Outline

SKB's LICENCE APPLICATION AND KBS-3 TECHNOLOGY

A key step in considering technology transfer is identifying and setting out a comprehensive description of the scope of the KBS-3[1] technology that underpins the SKB licence applications and which currently forms the basis for building systems for disposal of SNF both in Sweden and in Finland. Posiva, the Finnish spent nuclear fuel management company, adopted the KBS-3 technology in the 1980s and has contributed continuously to its development since then. The KBS-3 concept is shown in Figure S-1.

The responsibility for management of nuclear waste in Sweden is placed with the nuclear power industry. The Nuclear Waste Fund was established by law in 1982 to guarantee the "polluter pays principle".

[1] SKB's method was developed in the KBS project which started in 1977. The acronym KBS stands for "kärnbränslesäkerhet", meaning "nuclear fuel safety". The KBS-3 method (direct disposal of spent fuel assemblies in copper canister with cast iron insert) is described in the KBS-3 report, which was issued in 1983.

SKB, which is owned by the Swedish nuclear power companies, developed the KBS-3 technology for the disposal of SNF from the Swedish nuclear power plants. Altogether an estimated 6,000 copper canisters are needed for the SNF considered in the licence applications submitted in March 2011.

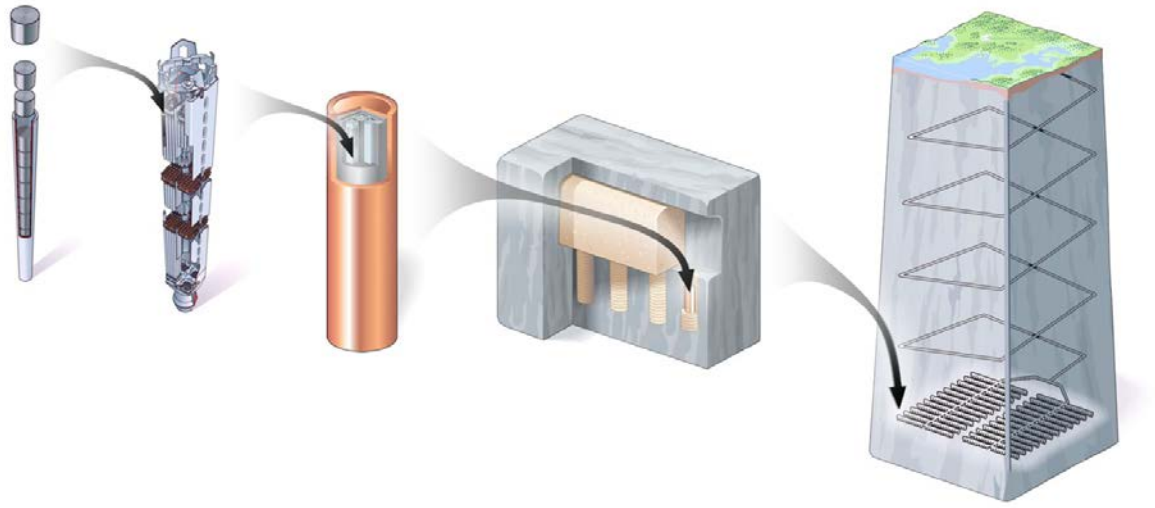

Figure 2. The KBS-3 method for deep geological disposal of Spent Nuclear Fuel (SNF).

CO-OPERATIVE WORKING

The NDA RWMD and SKB have been working together for the past 5 years to explore how the technology and knowledge developed in the Swedish programme could be transferred to the UK and to identify the potential benefits to both organisations. The initial stage was to conduct an opportunities review through a series of workshops and meetings to identify potential areas where technology or knowledge could be transferred from SKB to NDA RWMD through:

- Review of the NDA RWMD's Provisional Implementation Plan documentation[2];
- Initial considerations for canister development;
- A study to identify and quantify the potential benefits to RWMD of technology transfer from another waste management organisation.

The study provided an understanding of what information and technology are available now to improve confidence in the safety of geological disposal and what key information and data could be used to inform future disposal concept selection work [9]. The analysis of potential areas of interest and co-operation suggested that there is a significant amount of knowledge and technology that has been gained under SKB's programme that is potentially beneficial at this stage of the UK programme. Such work is generic to the application of a geological disposal facility concept irrespective of the specific details of the concept itself. As a result co-operation has continued to explore the benefits in terms of risk reduction and mitigation and exploring opportunities to save cost and time with specific aspects of the work programme.

[2] The NDA's Provisional Implementation Plan describes the activities skills and resources required to implement geological disposal in the UK; it is a basis for long term planning and cost estimates.

POTENTIAL BENEFITS AND RISKS OF TECHNOLOGY TRANSFER

The high applicability of the KBS-3 technology to a UK site with higher strength host rocks presents an opportunity to focus development work that needs to be carried out on issues specific to the UK. This would reduce or possibly in some cases eliminate the need to design, site, construct and operate large laboratories for establishing the scientific basis of the disposal concept and for developing and testing detailed technical solutions in full scale. It presents the opportunity to build upon existing scientific and technical material used in an existing comprehensive licence application. This material has already been subject to international review and is currently undergoing further scrutiny by the regulatory authorities in Sweden.

Reducing the scope of the UK development needs translates into a potential for lower costs, shorter schedule and reduced risks in the programme. Whilst the KBS-3 technology may be considered applicable there would be a need to adapt the technology to a UK site. Technology transfer is intended to reduce risks through the use of tested techniques and through a transfer of confidence, leading to a reduction in public acceptance risks. However, adaptation of imported technology will carry risks that will require management and mitigation; these risks could include political, economic, social, technical, legal or environmental risks.

SKB's actual incurred cost of SEK 12.7 billion (£1.15 billion, approx $1.5 billion) in 2012 value of money for the development of the KBS-3 technology until the submittal of the licence applications in 2011 is a reliable starting point for assessing the cost savings potential of a technology transfer of the KBS-3 concept.

Potential savings to other waste management organisations by employing the KBS-3 technology depends on several factors, including existing know-how and experience, the specific country needs and time scales. The real costs to develop a disposal technology today could be higher than the costs for SKB's past development due to the general international trend of more comprehensive requirements and more time-consuming licensing and stakeholder processes.

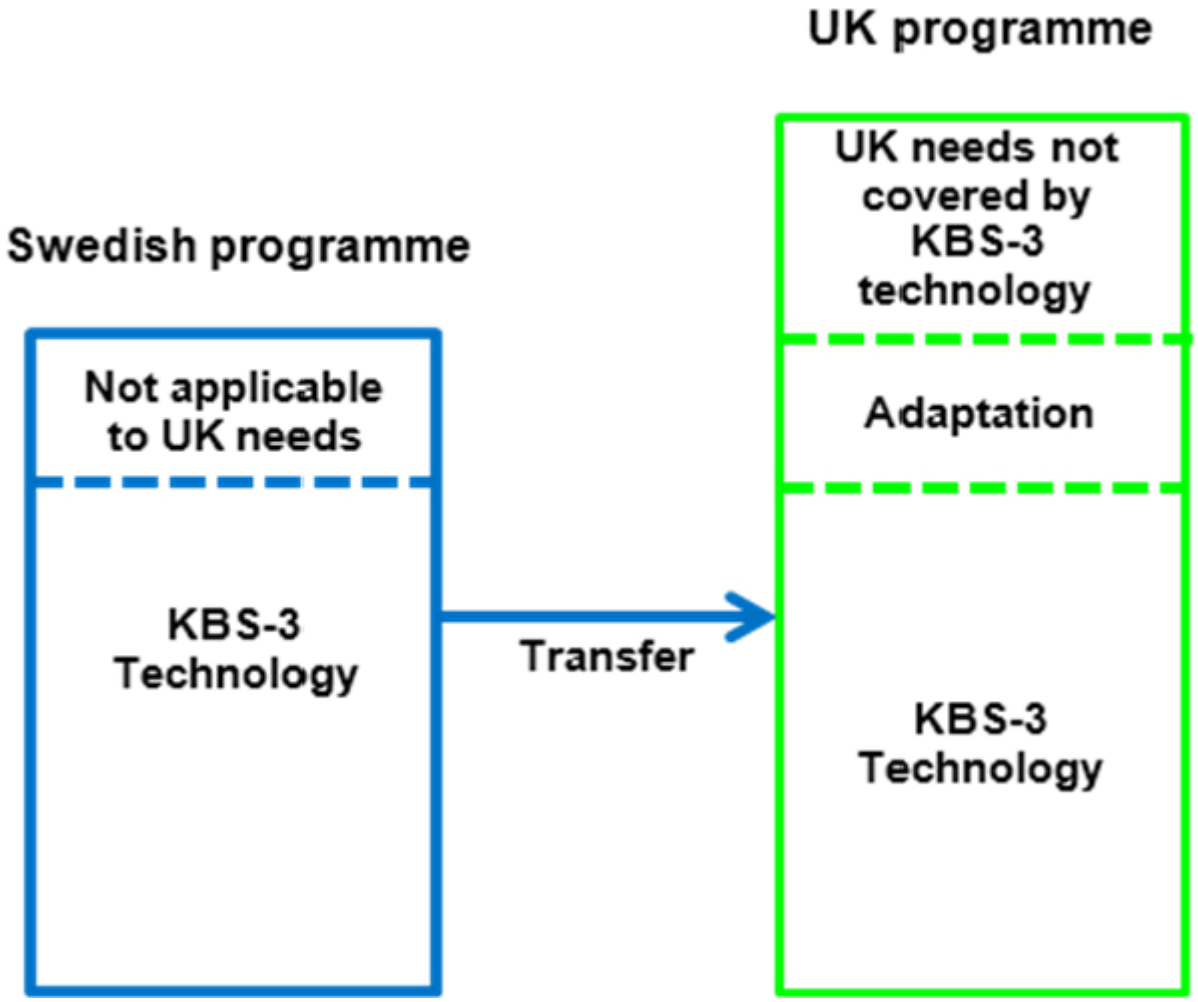

Figure 3

Technology transfer is considered to be a long term opportunity as the UK process is in the early stages of the siting process. The most significant benefits of close collaboration at the early stage of a disposal programme are considered to be regarding building confidence and competence within different countries as geological disposal programmes are implemented. As a precursor to technology transfer an element of knowledge transfer must first take place. As a result a number of joint initiatives are now underway:

- Secondment of staff from NDA RWMD to observe SKB experimental programme in the Äspö Hard Rock Laboratory has begun with the first secondment over the period August to December 2013.
- Use of existing demonstration facilities by other waste management organisations and international projects. Scaling up of Laboratory based experiments is a natural extension to the work of NDA RWMD. The UK has over 3 decades of R&D including the development of models and a sound series of laboratory based experiments; however it will be necessary to demonstrate that laboratory results are representative of GDF scale conditions. This type of evidence can then be used in support of any licence application.
- Possible mechanisms for technology transfer. As and when applicable, and to suit the needs of international GDF programmes, waste management organisations may wish

to transition from knowledge transfer to transfer technology. This would need to be based upon a sound and thorough business case and hence the knowledge transfer phase based on the initiatives such as those previously mentioned would need to be take place over a period of time which could span a few decades. However the potential benefits could be significant and hence the opportunity needs to be continually explored and assessed.

CONCLUSION

To date these studies have resulted in the joint exploration of how over £1bn (approx. $1.5 bn) of investment by SKB into geological disposal could be transferred and adapted to the UK context. This could include joint experimental work utilising the SKB demonstration facilities and the transfer of technology and experience of lessons learned to save time and money by not 're-inventing the wheel'.

The NDA RWMD is actively progressing work to understand and quantify the benefits of transferring mature technologies into its implementation programme. Difficulties have been encountered in applying the principles of technology transfer to a practical example; these include the detailed application of what is being transferred and the mechanism for transfer. However, the NDA RWMD believes that with further concerted effort these difficulties can be overcome and the work will continue as long as it shows that there could be benefits in either: duration, cost or risk reduction for the UK programme.

SKB International and NDA RWMD have worked together to explore the challenge of how to increase the credibility and competence in geological disposal against the many challenges and set backs to national programmes over the decades.

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