Geological disposal: key observations and lessons learnt

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The NEA has long been, and continues to be, a leading organisation in the field of radioactive waste management, and in particular as concerns geological disposal. The Agency's activities are broad in scope and address the policy, regulatory, technical and public-involvement aspects of this issue. It has helped the field move forward through joint and pioneering projects, such as the Stripa project in the 1980s, as well through regulatory and policy reflection. The NEA has developed what is today considered to be the reference approach to producing a disposal safety case.

The NEA's first major report dates from 30 years ago, when it issued the so-called "Polvani report" of September 1977 on *Objectives, Concepts and Strategies for the Management of Radioactive Waste Arising from Nuclear Power Programmes*. Since then much has been learnt.

Why geological disposal?

Whatever the future of nuclear power, it is generally recognised that safe and acceptable disposal solutions for existing and already committed long-lived, high-level radioactive waste must be pursued. There are no miracle solutions: physical transmutation of some of the waste or advanced fuel cycles will not eliminate the need for disposal. In addition, long-lived, high-level radioactive wastes are also generated from non-power applications of nuclear materials and isotopes, such as in medicine, industry and research.

Mature and safe methods for the management of radioactive waste are currently available and are being implemented. Society, as an extra precaution, has determined that some long-lived wastes, including high-level radioactive waste and spent fuel, should be disposed of such that they are contained and isolated from humans and the accessible environment without the need for continued human intervention.

International conventions prohibit disposal in the sea bed which, for all practical purposes, restricts disposal to land-accessible locations. Underground disposal is thus being investigated worldwide as the ultimate waste management end-point. The concept anticipates that any releases are small both relative to the overall inventory of waste and in absolute terms, and that these proportionately small releases migrate very slowly, resulting, at most, in a negligible incremental impact on public health.

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The level and time frame of protection that is demanded of, and can be provided by, a geological disposal system is unprecedented when compared to other practicable options, including those in common use for many non-radioactive but hazardous wastes. The placement of these wastes deep underground, in a robust engineered system matched to a suitable geological setting, is thus felt to afford appropriate protection for present and future generations.

The geological disposal concept, including its safety and ethical implications, has been debated in national legislatures, in state, provincial and local fora, by individuals, in peer-reviewed literature, in international organisations and by national scientific bodies. This reflects a general consensus on the geological disposal option, achieved through a broad societal process.

Delaying work on geological disposal, or adopting a "wait-and-see strategy", results in continuing and increasingly demanding care, which cannot be guaranteed. A long-term management option without a definite end-point is thus not only unacceptable ethically, but it is also potentially unsafe. Given this background, most countries have inscribed geological disposal in their policy objectives.

Where do we stand with geological disposal?

Since the Stockholm Conference of December 2003, important milestones in geological disposal have been reached in a number of NEA member countries. Having taken into account important public and stakeholder involvement, geological disposal is now the recognised reference solution in Canada, France and the United Kingdom. In France, a siting region has been identified for all long-lived, high-level radioactive waste. In Canada, a deep repository is being constructed for operational waste while a process is being defined for siting a repository for used nuclear fuel. The United Kingdom is now reflecting on how to set up a decision-making process that would associate local communities in the identification of a geological disposal site for radioactive waste.

In the meantime, other NEA countries which had already committed themselves to geological disposal have made important progress as well. In Finland and the United States, sites and designs have been identified and work is ongoing to develop the repositories. In Sweden, two localities have been short-listed and are now being investigated for the final siting of a deep repository. In Switzerland, after the promulgation of the new Atomic Energy Law, a plan has been drafted and is being implemented to search for repository sites. In Germany, a license has been granted to operate the deep repository at Konrad for "non-heat-emitting wastes", which include waste with long-lived components. Finally, it is worth noting that the Waste Isolation Pilot Plant (WIPP), a deep repository for transuranic waste, continues its successful operation in the United States.

Geological disposal is technically feasible

Central to successfully implementing geological disposal is the ability to demonstrate and communicate the safety and security of the repository system far into the future in a manner that is clear, scientifically sound and persuasive to decision makers and the public.

A wide consensus prevails on the general approach for the technical and safety assessments for geological disposal, and many examples exist of recent successful uses of safety cases for national decision making. Switzerland (2005) and France (2006) constitute the most recent examples. Exchanging information and working co-operatively under the aegis of international organisations such as the International Atomic Energy Agency (IAEA) and the OECD Nuclear Energy Agency (NEA) have been important factors in this progress.

NEA peer reviews have proven to be significant contributors to improving safety cases and to final decisions in moving national programmes to the next stage. This has been the case, for instance, in Japan, the United States, Switzerland and France. It may be noted that the two peer reviews concerning the United States were co-organised with the IAEA.

The deep disposal concept relies on the capabilities of both engineered barriers and the local geology to fulfil specific safety functions either in a complementary or in a redundant fashion. Considerable amounts of data and experience have been accumulating for sites and materials. In particular, there is an improved understanding of processes at various spatial and temporal scales, and significant advances in modelling techniques have been achieved. There are also several underground research, demonstration and/or development facilities. Overall, both the experts and the members of the public who have been involved feel that sufficient evidence exists to conclude that geological disposal is a technically achievable and safe solution.

Some broader challenges in practical implementation

Many national programmes are now facing the challenge of practical implementation of geological disposal through further development and licensing. From a regulatory point of view, the recommendations of the International Commission on Radiological Protection (ICRP), the IAEA Safety Fundamentals, and the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management provide a framework of common objectives to guide this implementation. This international framework provides goals and objectives for achieving an appropriate level of protection, including such elements as requiring a suitable regulatory framework, applying a stepwise approach in decision making, and protecting future generations without imposing undue burdens.

Although countries are implementing the international framework and pursuing common safety objectives, every country is at a different juncture in the process and has different needs. Some countries have found it essential to reflect unique repository attributes in the selection of repository performance criteria.

Regulators, implementers and policy makers have become more aware that confidence by the technical community in the safety of geological disposal is, by itself, not enough to gain public confidence and acceptance. There is now agreement that a broadly accepted national strategy is required to provide not only the means to build the facility, but also a framework and roadmap to provide both decision makers and the affected publics with the time and means to develop sufficient confidence in the various decisions at hand and, ultimately, in the achieved level of long-term protection. A first step in the strategy is the definition of a national energy policy which addresses the role of nuclear power and in which the waste arisings are recognised. The issuance of a national plan with indications for the final management of all types of radioactive waste is an important addition and basis for discussion and public acceptance.

Very importantly, the international framework, as embodied for instance in the Aarhus and Espoo conventions, also requires public information and stakeholder involvement, both nationally and across borders. Similar requirements are reflected in national laws, such as those concerning transparency in decision making and those requiring environmental impact studies.

The legitimacy of the process is paramount: national policy making and legislative bodies must put the process in place and provide the means to follow it. The quality of the process is also essential: roles must be clear; there should be adherence to both one's own roles and to the rules of the process; and all participants in the process must behave and be viewed as trustworthy and accountable.

It is interesting to note that there has been considerable evolution in the expected roles of the various actors over time (see Table). For example, the public increasingly views regulators as the "people's expert" and expects them to play this role. A capital role in the new decision-making environment is being taken on by the host communities. More and more often, they are becoming partners in negotiating locally acceptable solutions that minimise negative impacts and provide for local development, local control, partnership and, ultimately, a durable relationship between the facility and the host community.

A common objective, a variety of paths

Culture, politics and history vary from country to country and provide different contexts for establishing and maintaining public confidence. What works in one country may not be as effective in another. As a result of being open to different perspectives, it follows that there must be openness to countries reflecting individual cultural and societal values in their processes and regulatory criteria, which may result in similarities as well as differences on an international scale. For instance, what was expected to be a common regulatory approach and common safety criteria and time frame is now a more complex reflection of national and pan-national interests, local and regional cultural views and societal values. Differences in regulation and implementation may not only be appropriate, but may even be critical for public confidence and acceptance.

Cultural, societal and geographical similarities and differences may have resulted in a variety of paths, but common safety and security objectives underlie these paths in national disposal solutions. What is needed is a continued, shared understanding of how this progress is being achieved and how one might achieve the same objectives in one country while using a different path in another. International fora are important for identifying similarities and differences, as well as for identifying overarching themes and lessons to be learnt.

Traditional and evolving roles and responsibilities

Stakeholders	Traditional roles and responsibilities	Evolving roles and responsibilities
Policy makers	Defining policy options, investigating their consequences under different assumptions, making policy choices.	Informing and consulting stakeholders about policy options, assumptions, anticipated consequences, values and preferences. Setting the "ground rules" for the decision-making processes. Communicating the bases of policy decisions.
Regulators (policy makers in safety authorities)	Defining regulatory options, investigating their consequences under different assumptions, making choices regarding regulatory options.	Informing and consulting stakeholders about regulatory options, assumptions, anticipated consequences, values and preferences. Communicating the bases of regulatory decisions. Providing independent expertise for local communities.
Scientific experts, consultants	Providing qualified input for the decision makers.	Providing balanced and qualified input for stakeholders and encouraging informed and comparative judgement. Acting as technical intermediaries between the general public and the decision makers.
Implementers	Finding a solution for radioactive waste management and implementing that solution.	Co-operating with local communities to find an acceptable solution for radioactive waste management. Co-operating with local communities in implementing the solution.
Potential host communities	Accepting or rejecting the proposed facility.	Negotiating with implementers to find locally acceptable solutions for radioactive waste management that minimise negative impacts and provide for local development, local control and partnership.
Elected local or regional representatives	Representing their constituencies in debates on radioactive waste management facilities.	Mediating between several levels of governments, institutions and local communities in seeking mutually acceptable solutions.
Waste generators	Providing (partial or full) financing for radioactive waste management.	Providing financing for radioactive waste management under transparent arrangements and demonstrating this transparency.

Conclusions

At one time geological disposal of radioactive waste was viewed as if it were a relatively short-lived activity to be completed in the time span of perhaps a single generation, the goal being to provide a facility that could safely contain radioactive waste without any further action or intervention by future generations. Increasingly, the implementation of a disposal project has come to be viewed as an incremental process, perhaps taking several decades to complete. This changing vision involves not only the concept of protection of future generations, but also incorporates an assumption of their involvement in the process and a need to preserve their ability to exercise choice. The last decade or so has seen an evolution in the roles and number of relevant actors and, with that, a gradual shift in the complexity of the approach in implementing a disposal facility.

NEA work has considerably influenced the field of radioactive waste management and corresponding approaches around the world. At the October 2007 International Conference on Geological Repositories in Berne, Switzerland, countries reaffirmed the common objective of safe geological disposal and reinforced the message that continued attention by decision makers is an important element in helping to keep on course a process that will take decades to complete. They also reached a common understanding that the varieties of paths available represent complementary avenues, which arise from modern and democratic, but nation-specific approaches to governance. The communication of this shared understanding by decision makers can have a significant impact on the confidence of all stakeholders. ■