

International Conference on Radioactive Waste Disposal
GEOLOGICAL REPOSITORIES: A COMMON OBJECTIVE, A VARIETY
OF PATHS

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The Safety of Geological Disposal- Convergence of International
Perspectives

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At a time when we are witnessing an expansion of nuclear power programmes to meet the increasing energy demands in many parts of the world, radioactive waste disposal continues to be high on the nuclear policy agenda of many countries. Together with the overall safety of nuclear power plants and decommissioning, waste disposal and in particular the safety of geological disposal, remains a key concern of the public and the news media. The plans for new and reinvigorated nuclear power development worldwide need to be complemented by equally ambitious plans for the establishment and enhancement of sustainable radioactive waste management programmes encompassing all types of waste generated by the nuclear fuel cycle; up to and including their final disposal.

While considerable experience has been accrued in operating radioactive waste disposal facilities located in the near surface environment, the geological disposal of high level waste and spent fuel has yet to be demonstrated. Good progress is being made in a few countries, with the possibility to have operational facilities around 2020. In most countries with nuclear power programmes, however, programme schedules are slipping and little real progress towards the siting and development of disposal facilities is seen. This is a worrying development; particularly as an increasing number of countries announce their intention to introduce nuclear power.

The failure to properly address waste disposal in the first decades of nuclear energy development have left a legacy of doubt in the minds of the public and politicians over its overall safety. If this doubt is not ameliorated soon, it could well lead to all the ambitious plans to expand the use of nuclear power on a global scale being significantly delayed.

The last two decades have seen the principal elements of a global nuclear safety and security regime covering radioactive waste disposal develop and become established. The Joint Convention on the Safety of Spent Fuel and Radioactive Waste was negotiated and agreed in the late nineteen nineties and is now in force, the international safety standards are maturing, and together with national

legislations and regulations have already contributed significantly to improvements in the safety of radioactive waste management around the world.

The Contracting Parties to the Joint Convention have now held two review meetings. The meetings have identified areas where significant progress has been made, particularly in the establishment of holistic national waste management policies, including decommissioning activities, and in the management of legacy waste. A number of challenges have been identified in the implementation of these policies, amongst which are the long term management of spent fuel, the disposal of high level waste and the need to find suitable disposal options for all types of radioactive waste. With respect to the latter, the IAEA convened an international workshop in July this year where the concept of a common framework linking all waste types with disposal options was discussed and where a convergence of ideas was evidenced. The waste types suitable for near surface disposal and geological disposal were discussed, as was the potential utility of disposal at intermediate depths of waste for waste that does not require the degree of containment and isolation afforded by geological disposal.

The role of the international safety standards to improve safety worldwide and their utility has been significantly enhanced since the approval initially of a set of three Fundamental Safety Principles for nuclear safety, radiation safety and radioactive waste safety by the Board of Governors of the IAEA in the mid nineteen nineties. A consolidation of these principles into a single Safety Fundamentals document has recently been achieved, a development setting the scene for greater harmonization of the approach to safety across the whole spectrum of nuclear and radiation related technologies. Safety Requirements documents covering all nuclear installations and other facilities and activities where radioactive materials are used or handled have since been developed and used by many countries in national legislation and regulatory processes.

The suite of documents within the Safety Standards Series devoted to radioactive waste management is now comprehensive. In particular, the Safety Requirement on the Geological Disposal of Radioactive Waste, published in 2006, represents a significant development in the substance, structure and style of IAEA safety standards and a model for future standards. In view of the increasing interest in the safety of geological disposal and the national sensitivities in respect of public and political acceptance, this standard was subject to intense scrutiny by all Member States of the IAEA, and the NEA, who co-sponsored its development and approval. As such it forms a substantial point of reference for safety demonstration. The requirements are set out in 23 discrete paragraphs which make use of the word *shall* in defining safety imperatives. The requirements are supported by explanatory text that elaborates on their de facto implications. A Safety Guide is in preparation

to provide guidance on meeting the requirements consistent with prevailing best practice.

Concentrating and containing radioactive waste and isolating it from the biosphere is the accepted strategy for its management within the global nuclear safety and security regime developed and adopted by IAEA Member States. Disposal in stable geological formations several hundreds of metres underground is deemed to provide the necessary degree of containment and isolation for high level waste, and as such it is widely considered to be an appropriate method for the disposal of such waste. Good progress towards geological disposal has been made in the development of techniques for encapsulation of the waste, site investigation and characterization, disposal facility excavation, waste package emplacement, and development of buffer and backfill materials. Sophisticated modelling techniques have also been developed to assist in assessing the safety of geological disposal facilities, covering both the engineered and natural components of disposal systems.

Nevertheless, the key issue in all programmes concerned with disposal facility development and operation is the need to provide a convincing demonstration of their safety and security, particularly their long-term safety. Demonstrating that protection of the public and the environment has been adequately provided for over long timescales requires the behaviour of the disposal facility to be predicted and modelled into the distant future, a complex undertaking involving many processes and interactions within the disposal facility itself and its host geological environment. The modelling results have to be compared with radiation protection criteria, a process complicated by the range of values obtained when a multitude of possible scenario evolutions are computed. Different approaches to addressing these issues have been adopted in different countries and this remains an area where further harmonization is foreseen.

The subject of such safety demonstration is clearly one where international harmonization is essential, particularly in the light of ever increasing globalization of technologies and information availability; a situation which clearly calls for further international cooperation. The recently published international safety standard, *Safety Requirements for Geological Disposal* provides an up to date point of reference for safety demonstration for geological disposal facilities and a sound basis for inter-comparison. It has been used recently by a group of European countries interested in developing a harmonized approach to safety demonstration of geological disposal within the European region. In view of, and complimentary to these developments, the IAEA has recently established an international project to work towards harmonization of approaches worldwide to demonstrating the safety of geological disposal - the GEOSAF project.

The project will provide a global forum to examine the evolution of arguments, assessments and supporting evidence, developed to provide a reasonable level of assurance of the safety of geological disposal and will give particular attention to their systematic review by the regulatory body. The project will complement the experience gained in a number of similar international projects undertaken by the IAEA and the NEA and other authorities relating to safety demonstration. Both similarities and differences in approaches taken in different countries will be identified and the differences analysed in order to understand the reasons. Further dialogue and exchange will then take place with a view to understanding if the same end point is being achieved by the different approaches or if in fact a preferred approach can be identified.

Geological disposal of high level waste, not only provides a safe disposal environment, but also provides for a high level of physical security. The degree of containment and isolation associated with geological disposal largely precludes security concerns. Nevertheless, security provisions for transport to and storage on sites prior to disposal will require due attention. The amended *Convention on the Physical Protection of Nuclear Material* (CPPNM), when entered into force, sets requirements for states to implement physical protection measures not only for nuclear material in international transport but additionally for domestic transport and for facilities in which nuclear material is produced, processed, used, handled stored or disposed of. These measures should address proliferation concerns (theft) and sabotage leading to severe radiological consequences.

The more practical aspects of nuclear safeguards continue to be an issue of consideration for geological disposal of spent nuclear fuel. In 2006, the so-called ASTOR (*Application of Safeguards to Geological Repositories*) working group was established by the IAEA with the objective of developing new safeguard approaches for geological disposal facilities that are planned to be operational in the foreseeable future, such as the Finnish facility at Olkiluoto. The approach is being developed in the framework of Integrated Safeguards which, in the future, will constitute an optimum combination of all safeguards measures in order to achieve the maximum effectiveness and efficiency.

A third major issue with respect to the management and disposal of high level waste is the multinational approach to developing a geological disposal facility. Many countries, and in particular those planning to launch nuclear power programmes, have or will have comparatively small volumes of high-level radioactive waste. It would appear to be disproportionately costly for each country to develop its own geological disposal facility. In line with IAEA initiatives promoting the development of shared nuclear fuel cycle facilities for its Member

States, studies have been initiated at a regional level, to examine the feasibility of regional disposal facilities in which the waste from several countries could be placed. For some time now initiatives have been underway and interest expressed in multinational approaches to dealing with different aspects of the nuclear fuel cycle from reprocessing to storage of spent fuel and more recently disposal. The rationale is broad; ranging from the capacity of countries to develop geological disposal facilities to the availability of adequate geological formations and fundamentally the economy of scale. The IAEA has, at the request of its Member States, created forums for the discussion of multinational disposal, considering both the infrastructural framework and the scenarios of implementation for waste disposal facilities. In addition to cost and safety considerations, recent events have highlighted the security and non-proliferation benefits that could be gained by multinational approaches to storage and disposal.

In 2004, an international Expert Group on Multilateral Nuclear Approaches was established by the Director General of the IAEA to advise on possible multilateral approaches to the nuclear fuel cycle. Incentives and disincentives for multilateral cooperation at the policy, legal, security, economic and technological levels were discussed, as well as the possible roles of international organizations. The findings of this expert group were published in 2005. Increasingly the issue of shared disposal facilities is the subject of panels at international conferences — considering possible scenarios, conditions for successful implementation, benefits and challenges. In this context further consultation is scheduled by the IAEA with interested countries in order to develop a deeper understanding of the legal and institutional aspects involved.

Public acceptance still remains as one of the main challenges for organizations charged with the development of any radioactive waste disposal facility. This is vital for national facilities and even more so for multinational facilities. Gaining public acceptance is not an easy undertaking and it can very easily be lost. The only real way forward to gain acceptance is to have a very open and transparent decision making process and to involve all relevant stakeholders and interested parties in this process, particularly local communities. How this is done will vary between the countries based on their legal system and the extent that the national culture calls for participative decision making processes. The Agency will shortly publish a document on factors affecting public and political acceptance for geological disposal, drawing on the experiences from several countries and emphasising the importance of a clear and open decision process taking into account the technical as well as the social dimension.

In conclusion, the development of geological disposal facilities is essential to the further development of nuclear power on a global scale. Fundamental to such

development is communication with and acceptance by the public and all relevant stakeholders. Much has been achieved in developing a global safety regime and increasingly networks are being established that facilitate knowledge management and exchange of experience — to promote the good practice highly necessary to ensure the safety of nuclear facilities and activities. The IAEA continues to play a key role in supporting the Joint Convention by encouraging countries to become Contracting Parties and working towards improvements in the review process, including wider sharing of the Review results. The IAEA continues to assist with continuous review and improvement of international safety standards, in exchanging technical experience and in providing peer review and advisory services based on these standards. Increasingly the Joint Convention and the amended CPPNM underpin the global safety and security regime for spent fuel and radioactive waste management. The development of geological disposal facilities for high level waste is nevertheless contingent on building the confidence of all parties concerned in their safety. For this reason, a transparent and internationally harmonised approach increasingly becomes a *sine qua non* and perhaps the time is opportune to organize a high level global forum for more continuous in-depth, international dialogue between implementers, regulators, policy-makers and international organizations, to pave the way forward in such an endeavour.