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NUCLEAR ENERGY AGENCY
**RADIOACTIVE WASTE MANAGEMENT COMMITTEE**

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# MOVING FORWARD WITH GEOLOGICAL DISPOSAL OF RADIOACTIVE WASTE:

## AN NEA RWMC COLLECTIVE STATEMENT

*This document represents the final version of the collective statement of the RWMC on moving forward with geologic disposal. Intent is to produce a publication and a flyer in the near future.*

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# FOREWORD

The Nuclear Energy Agency's (NEA) Radioactive Waste Management Committee (RWMC) is a forum of senior representatives from operators and industry, safety authorities, policy makers, and research and development institutions engaged in the management of radioactive materials and waste. With its broad representation and the wide range of external expertise that its members can muster, the RWMC is a uniquely placed international forum to assist NEA member countries to address issues concerning the management of radioactive materials and waste. The RWMC serves this objective by fostering collective understanding and providing guidance on state-of-the-art approaches and practices in the fields of radioactive waste management and the decommissioning of nuclear facilities.

Radioactive waste is associated with all phases of the nuclear fuel cycle and with the use of radioactive materials in industrial, medical, defence-related and research applications. All such waste must be managed safely. The most hazardous and long-lived radioactive wastes, such as spent nuclear fuel and high-level waste from fuel reprocessing, must be contained and isolated from humans and the environment for many tens of thousands of years. Disposal of these wastes in engineered facilities, or repositories, located deep underground in suitable geological formations is being developed and further investigated world wide as the reference solution in order to protect humans and the environment both now and in the future. Engineered geological disposal is thus seen as the radioactive waste management end-point providing safety without the need for continued human intervention.

The RWMC underscored the environmental and ethical basis for geological disposal as well as its technical feasibility in a number of previous collective statements. In the intervening time since the issuance of these collective statements, no developments have undermined the basic conclusions. There have been, however, advances and evolving views regarding the relevant methodologies, policies, and decision-making processes and much further practical experience has accumulated regarding development of geological repositories.

It is useful to review periodically both technical and societal aspects of national experience to assess the implications for the continued development and implementation of geological repositories. Drawing on the developments in the last decade, the Committee expresses hereafter, in a concise form, its collective views on why geological disposal remains an appropriate waste management choice for the most hazardous and long-lived radioactive wastes, on current status of geologic disposal, on challenges and opportunities to implementation, and on expectations for further development. Following the collective statement, further background information is provided on key points.

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## Why is geological disposal appropriate for high-activity, long-lived radioactive waste?

- Radioactive waste is associated with all phases of the nuclear fuel cycle and with the use of radioactive materials in industrial, medical, research and defence-related applications. All such waste must be managed safely and in a manner that protects humans and their environment.

- The most hazardous and long-lived radioactive wastes, such as spent nuclear fuel and high-level waste from fuel reprocessing, must be contained and isolated from humans and the environment for many tens of thousands of years.

- Whatever the future of nuclear power in the different countries, it is universally recognized that safe and acceptable disposal solutions must be pursued for existing and projected inventories of high-activity, long-lived radioactive waste from current practices.

- A geological disposal system provides a unique level and duration of protection for high-activity, long-lived radioactive waste. The concept takes advantage of the capabilities of both the local geology and the engineered materials to fulfil specific safety functions in complementary fashion providing multiple and diverse barrier roles.

- The overwhelming scientific consensus world-wide is that geological disposal is technically feasible. This is supported by the extensive experimental data accumulated for different geological formations and engineered materials from surface investigations, underground research facilities and demonstration equipment and facilities; by the current state-of-the-art in modelling techniques; by the experience in operating underground repositories for other classes of waste; and by the advances in best practice for performing safety assessments of potential disposal systems.

- Disposal can be accommodated in a broad range of geological settings, as long as these settings are carefully selected and matched with appropriate facility design and configuration and engineered barriers.

## Where do we stand with geological disposal in OECD countries?

- Having taken into account significant public and stakeholder involvement, many countries have adopted geological disposal as the reference long-term management solution for their high-activity, long-lived radioactive waste.

- Progress towards implementation is evident in a number of countries. For countries that have faced challenges and setbacks with respect to implementation, geological disposal still remains the reference option.

- With the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, the Safety Standards of the International Atomic Energy Agency, and the recommendations of the International Commission on Radiological Protection there is now a common framework that guides national regulatory oversight and implementation of disposal.

- For programmes that are most advanced, implementation of geological disposal builds on a strategy that accommodates continuous learning and includes a willingness to incorporate evolution in technical advances and societal requirements.

- The search for, and selection of, a site is a critical step that has proven to be politically and socially challenging. Recent successes show the benefit of open and transparent processes that allow sufficient time and include a concerted effort to assure that there is meaningful involvement of all stakeholders in the decision-making processes by following a flexible and adaptable strategy.

- Ethical aspects, including considerations of fairness to current and future generations, are important for the development of disposal programmes.

- Cultural, societal, and geographical similarities and differences have resulted in a variety of paths towards implementing national disposal solutions, but a common safety and security objective underlies all these paths.

**Challenges and opportunities in practical implementation**

- Regulators, implementers and policy makers have increasingly become aware that confidence by the technical community in the safety of geological disposal is not, by itself, enough to gain public confidence and acceptance.

- There is consensus that a broadly accepted national strategy is required. This strategy should address not only the technical means to construct the facility but also a framework and roadmap allowing decision makers and the concerned public the time and means to understand and evaluate the basis for various proposed decisions and, ultimately, to gauge whether they have confidence in the level of protection that is being indicated by the implementing organisation and evaluated by the regulator through its independent review.

- Reversibility and retrievability are considered by some countries as being important parts of the waste management strategy. Reversibility implies a disposal programme that is implemented in stages and that keeps the options and choices open at each stage, and provides the capacity to manage the repository with flexibility over time under specified conditions. Retrievability is the possibility to reverse the step of waste emplacement. There is general recognition that it is important to clarify the meaning and role of reversibility and retrievability for each country, and that provision of reversibility and retrievability must not jeopardise long-term safety.

- Technical development and implementation of disposal projects may demand decades to realize. The long implementation times afford opportunities for programme adaptation and enhancement. The related challenge is to maintain the support at both local and national levels, the necessary infrastructure, and human resources for knowledge preservation and transfer.

- Phased decision-making has come to the fore as the preferred approach to deal with the long implementation times. Besides allowing for continued research and learning, phased decision-making provides the opportunity to build broad societal confidence in the concept and to develop constructive relationships with the most affected regions. The related challenges are to maintain the processes and relationships, integrate advances, and ensure forward momentum.

**Broad expectations on further development of geological disposal**

- Collective experience and knowledge transfer have been helpful in facilitating development. International cooperation and sharing of research projects, experiences and lessons learnt should continue.

- Delaying work on geological disposal – i.e. by adopting a "wait and see" strategy – would require increasingly more demanding care for the waste and its storage facilities. Moving forward with implementation of geological disposal is, thus, desirable from the point of view of both ethics and safety. Sufficient information now exists to take the first steps and put a plan in place commensurate with the current generation's responsibility.

## BACKGROUND INFORMATION ON KEY POINTS

This section provides further details and background information on issues addressed in the collective statement. Many of the findings are also applicable to the development of radioactive waste management facilities other than geological repositories as well as for classes of waste other than high-activity, long-lived radioactive waste.

**Why geological disposal of high-activity, long-lived radioactive waste?**

- High-activity, long-lived radioactive waste from nuclear-power related activities includes spent fuel from reactor operation, high-level waste from spent fuel reprocessing and intermediate-level long-lived waste mostly from spent fuel reprocessing. Small quantities of high-activity, long-lived radioactive waste can also arise from other uses of nuclear materials, such as in medicine, industry, and research.

- Whatever the future of nuclear power, it is universally recognized that safe and acceptable end points must be pursued for existing and projected inventories of high-activity, long-lived radioactive waste. Various options have been considered and discarded for political or safety reasons, such as disposal under the sea bed or transport to space. Transmutation of part of the waste through use of advanced nuclear fuel cycles, although perhaps feasible in the coming decades, would not eliminate the need for managing the currently existing waste and residual quantities of high-activity, long-lived radioactive waste.

- Geological disposal has thus been investigated worldwide, and is now being further developed in several countries, as the ultimate waste management end-point for high-activity, long-lived radioactive waste. At depths of hundreds of metres, the rock formation will protect the disposal facility from human interference and from natural processes such as earthquakes and climate changes. Additionally, careful selection of the disposal facility location and waste positioning aim to reduce as far as practicable the risks of perturbations from such processes.

- A geological disposal system provides a unique level and duration of protection for high-activity, long-lived radioactive waste. The concept of geological disposal takes advantage of the capabilities of both the local geology and the engineered materials to fulfil specific safety functions in complementary fashion providing multiple and diverse barrier roles.

- Releases from the engineered barriers would occur thousands of years after disposal and would be very small. Additionally, these small releases are diluted and slowed by the geological formation surrounding the repository and are further reduced by radioactive decay. The ensuing potential radiological exposure in the biosphere would not represent, at any time, a significant increment above the natural background.

- A variety of geological settings have been investigated and proven amenable for hosting a disposal facility. In all these cases, it is considered feasible to devise engineered systems to complement the isolation function of the geological barrier. Geological disposal can thus be implemented in a broad range of rock types and geological settings.

- The concept of geological disposal, including its safety and ethical implications, has been debated and approved in many forums, including national legislatures; state, provincial and local discussions; by individuals; in peer-reviewed literature; by international organizations; and by national scientific bodies. This demonstrates a broad consensus on the geological disposal option, achieved through open and participative processes in many nations.

- Delaying work on geological disposal – i.e. by adopting a wait and see" strategy – would require continuing and increasingly more demanding care for the waste and its storage facilities. Over the long term, wastes stored at or near the surface are more vulnerable to extreme natural events or terrorism than wastes disposed deep underground. Against this background, many OECD countries have determined that their high-activity, long-lived radioactive wastes should be disposed so that they remain safely isolated without continued human intervention and have incorporated geological disposal within their policy objectives. Long-term management with a definitive end-point that is founded on long-term safety provides an ethical basis for current generations to deal with the waste.

**Where do we stand with geological disposal?**

- Since the previous RWMC status review of 1999, important milestones in geological disposal have been reached in a number of NEA member countries. Namely, having taken into account significant public and stakeholder involvement, final isolation of high-level waste, spent fuel and other classes of waste with long-lived components in geological repositories is now the recognized reference solution in Canada, France, and the United Kingdom. Recently, in France, a siting region has been identified for all high-activity, long-lived radioactive waste; in Canada, an environmental assessment is underway for a deep geologic repository for low- and intermediate-level waste, which includes waste with long-lived components, and a process is being defined for siting a deep repository for spent nuclear fuel. The United Kingdom is now beginning to develop a decision-making process that would involve local communities in the identification of a geological disposal site for several classes of radioactive waste.

- Meanwhile, other NEA member countries that had already committed themselves to geological disposal have reached important milestones. In the United States, a license application has been developed and was submitted for review to the U.S. regulator in 2008. In Finland, a site and a disposal system design have been identified and work is ongoing towards the development of a license application to allow the construction of a deep disposal facility for spent fuel. In Sweden, a reference design has been developed and two sites are being characterised. Selection of the Swedish site for final disposal of spent fuel is approaching. In Switzerland, a broad, transparent and stepwise site selection process has been initiated as required in the new nuclear energy legislation. In Japan, after promulgation of the Final Disposal Law for high-level waste disposal, which has been amended to include other long-lived waste (referred to as "trans-uranium waste"), a stepwise siting process has started and is ongoing. In Germany, a license has been granted to operate the deep disposal facility at Konrad for "non-heat emitting wastes", which include waste with long-lived components. Finally, it is worth remembering that the Waste Isolation Pilot Plant (WIPP) facility, a deep geological disposal system for long-lived "transuranic waste", continues successful operation in the United States.

**Geological disposal is technically feasible**

- The concept of geological disposal benefits from the capabilities of both engineered barriers and the local geology to fulfil specific safety functions in a complementary fashion, providing multiple and diverse barrier roles. A large database regarding geology and materials has been accumulating; there is an improved understanding of processes at various spatial and temporal scales and significant advances in modelling techniques have been achieved. There also exist several underground research, demonstration and/or development facilities. Experience has continued to accumulate in the management of deep or intermediate-depth repositories for the disposal of other classes of radioactive wastes.

- Although the wealth of technical information and experience gained through some three decades of research has not revealed any concerns that would hold back actual implementation, this does not mean the research can or should stop. Research and development are ongoing in all national and international programmes and are meant to accompany and guide the development of repositories all along their implementation.

- The prevailing view of technical experts, as well as of many members of the general public that have been familiar with the work relating to geological disposal, is that geological disposal is a safe and technically achievable solution. There will always be some stakeholders that will not be fully convinced of the pertinence and safety of a specific geological disposal proposal. This is a reality in any societal decision process. Value and perception differences are real and must be respected, and there must be a continued dialogue to air these differences. In the end, important societal decisions have to be made, and the role of the regulatory system in determining whether a geologic disposal facility is sufficiently advanced and safe for implementation must be respected.

- Central to successfully implementing geological disposal is the ability to demonstrate and communicate the safety and security of the disposal system far into the future in a manner that is clear, scientifically sound and persuasive to decision-makers and the public. There is now a wide consensus on the main elements of the technical safety assessment for a geological disposal system, and many examples exist of recent successful uses of safety cases for national decision-making. Switzerland (2006) and France (2006) constitute the most recent examples.

- Exchanging information and working cooperatively under the aegis of international organizations such as the International Atomic Energy Agency (IAEA) of the United Nations and the Nuclear Energy Agency (NEA) of the Organisation for Economic Co-operation and Development have been important factors in progress to date. Multi-partner research and development projects, such as those involving several countries and sponsored by the European Commission, also make valuable contributions.

- International peer reviews of waste disposal concepts and plans, such as those organised by the NEA, have been important contributors to final decisions in moving national programmes to the next stage. This has been the case, for instance, in Japan, the USA, Switzerland and France.

**Some broader challenges in practical implementation**

- We are now facing the challenge of practical implementation of geological disposal through further development and licensing and application of the international guidance. International conventions and guidance under the aegis of expert bodies, such as the International Commission on Radiological Protection (ICRP), the IAEA and the NEA, provide a suitable framework for applying a stepwise approach in decision-making and protecting future generations without imposing undue burdens on them. Additional international guidance is available regarding environmental impacts, including cross-border information and rights to information and justice, such as guidance provided in the regional Espoo and Aarhus conventions.

- Although countries are implementing the international framework and pursuing a common safety objective, each country is at a different stage in the process and countries have different cultural, legal and geological settings that impose different needs. The selected performance criteria are expected to be a reflection of the specific conditions in the relevant country.

- Mechanisms such as radioactive waste policies, legislation and regulations have been used effectively to provide a basis for the management of radioactive wastes. In some countries, the definition of a national energy policy that addresses the role of nuclear power, waste arisings and the need for their safe management is considered a first effective step in the strategy to achieve geological disposal. The issuance of a national plan with indications for the final management of all types of radioactive wastes can be an important addition and basis for discussion and public acceptance.

- The international framework also requires public information and stakeholder involvement, both nationally and across borders. Similar requirements are reflected in national laws, e.g., those concerning transparency in decision making and those requiring environmental impact studies.

- The legitimacy of the process is paramount: national policy and legislating bodies must be visible in putting the process in place and in verifying that it is implemented as planned.

- The quality of the process is also paramount: (a) roles and responsibilities must be clear; (b) all parties should adhere to both their own roles and to the rules of the process; (c) all participants in the process must behave in a trustworthy and accountable manner in order to maintain the respect of other participants.

- There has been important evolution in the expected roles of the various actors over time [see Table 1]. Regulators, for instance, are increasingly viewed by the public as the "people's expert". In some nations, separately chartered technical review groups perform a similar and/or complementary function. An essential role in the new decision-making environment is being played by the host communities. Host community leaders are increasingly becoming partners in negotiating for locally acceptable solutions that help avoid or minimise potentially negative impacts and provide for local development, participation in option identification and decision making, and, ultimately, the establishment of a lasting relationship between the facility and the community.

- Reversibility and retrievability are considered by some countries as being important parts of the waste management strategy. Reversibility implies a disposal programme that is implemented in stages and that keeps the options and choices open at each stage, and provides the capacity to manage the repository with flexibility over time. Retrievability is an example of reversibility that describes the possibility to reverse the step of waste emplacement. Such measures, especially if an extended period of access to the waste is envisioned, also have implications for security, for requiring an observation or confirmation period, for safety and cost. The time limits over which such measures are effective and achievable should be defined and explained.

**A common objective, a variety of paths**

- Culture, politics, and history vary from country to country, providing different contexts for establishing and maintaining public confidence. What works in one country may not be as effective in another. As a result of openness to different perspectives, there must be openness to nations reflecting individual cultural and societal values in their processes and regulatory criteria, which may result in similarities, as well as differences, among national approaches to geological disposal. Safety criteria and time frames are a 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 have resulted in a variety of paths, but a common objective with respect to safety and security underlies these paths in national disposal solutions. National disposal solutions need a continued, shared understanding of how this progress is being achieved elsewhere and how the same objective may be achieved in a specific country, but perhaps on a different path. International forums are important to identify similarities and differences and to identify overarching themes and lessons to be learnt.

Table 1 **Traditional and evolving roles and responsibilities of main actors**

| **Stakeholders** | **Traditional expectations for roles and responsibilities** | **Evolving expectations for 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 preference.<br>Setting the "ground rules" for the decision making processes.<br>Communicating the bases of policy decisions. |
| Regulators | Defining regulatory options, investigating their consequences under different assumptions, making choices regarding regulatory options.<br>Communicating the bases of regulatory decisions. | Maintaining open and impartial regulatory processes.<br>Providing stakeholders with understandable explanations of the mechanisms of regulatory oversight and decision making, including explanations of the opportunities available for stakeholder partici-pation therein.<br>Serving as a source of information and expert views for local communities. |
| Scientific experts, consultants | Carrying out scientific/technical investigations with integrity and independence.<br>Advising institutional bodies such as safety authorities and implementing agencies on technical issues in relation with safety concerns with the view to providing balanced and qualified input for decision making. | Acting as technical intermediaries between the general public and the decision makers.<br>Providing balanced and qualified input for all stakeholders and encouraging informed and comparative judgement. |
| Implementers | Finding a solution for the radioactive waste management problem, implementing the solution. | Co-operating with local communities to find an acceptable solution for radioactive waste management.<br>Co-operating with local communities in implementing the solution.<br>Interacting with policy-makers and regulator |
| Potential host communities | Accepting or rejecting the proposed facility. | Negotiating with implementers to find locally acceptable solutions for radioactive waste management that help avoid or minimise potentially negative impacts and provide for local development, local control, and partnership.<br>Interacting with policy-makers and regulator |

| | | |
|---|---|---|
| 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.<br>Interacting with regulator and implementer |
| Waste generators | Providing (partial or full) financing to implement radioactive waste management solutions. | Providing financing for developing and implementing acceptable radioactive waste management solutions under transparent arrangements and demonstrating this transparency. |

## PREVIOUS COLLECTIVE STATEMENTS OF THE RWMC

The RWMC underscored the environmental and ethical basis for geological disposal as well as its technical feasibility in a number of previous collective statements.

**NEA 1985,** "Technical Appraisal of the Current Situation in the Field of Radioactive Waste Management -- A Collective Opinion by the Radioactive Waste Management Committee", OECD/NEA, Paris. See also Appendix 7 in Geological Disposal of Radioactive Waste: Review of Developments in the Last Decade, OECD/NEA, 2000]

**NEA 1991**, Can Long-Term Safety Be Evaluated? - An International Collective Opinion, OECD, Paris.

**NEA 1992,** "Statement by the NEA Radioactive Waste Management Committee on the Partitioning and Transmutation of Actinides" (April 1992), published in the NEA Nuclear Waste Bulletin, No. 7, July.

**NEA 1995,** The Environmental and Ethical Basis of Geological Disposal of Long-Lived Radioactive Wastes - A Collective Opinion of the Radioactive Waste Management Committee, OECD, Paris [http://www.nea.fr/html/rwm/reports/1995/geodisp.html]

**NEA 1999**, Progress Towards Geologic Disposal of Radioactive Waste: Where Do We Stand? OECD, Paris [http://www.nea.fr/html/rwm/reports/1999/progress.pdf]