

Radioactive Waste Management

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A Common Objective, a Variety of Paths

**Synthesis and Main Lessons:
Third International Conference
on Geological Repositories
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NUCLEAR ENERGY AGENCY
ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

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The NEA Data Bank provides nuclear data and computer program services for participating countries. In these and related tasks, the NEA works in close collaboration with the International Atomic Energy Agency in Vienna, with which it has a Co-operation Agreement, as well as with other international organisations in the nuclear field.

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FOREWORD

Radioactive waste arises from the operation of nuclear power plants and from the use of radioactive materials in medicine, industry and research. Methods for the safe, interim management and storage of all types of radioactive waste are available and are being implemented in all countries that possess such wastes. In general, disposal is the final aim and wastes are being stored until suitable disposal facilities are available.

Disposal facilities for short-lived, low- and intermediate-level radioactive waste are already operating in many countries. For high-level radioactive waste (which includes spent nuclear fuel if treated as waste), disposal in an engineered repository in a deep, stable, geological formation – geological disposal – is the preferred long-term management option in all countries where a decision on the final end point has been taken.

Geological disposal is widely accepted as a scientifically sound method of ensuring the long-term safety and security of radioactive waste isolation that can be implemented using currently available technology. An international framework has been established to promote and assess the safety and security of radioactive waste management activities, including geological disposal, and is incorporated in international conventions, national laws and regulatory guidance.

In modern societies, however, the implementation of any major new technological project, besides proving its technical merits and safety, must also satisfy societal and political requirements; this has been a particular challenge to geological disposal in many countries. Thus, while the goal of deep geological disposal is widely accepted, the path towards implementation depends on a variety of factors including the national political and legislative framework, economic conditions and the societal or cultural approach to decision making.

There is a practical need to move forward with geological disposal projects in order to deal with the long-term waste liabilities of past and committed nuclear power programmes. Progress towards the implementation of geological disposal has been made in several countries but, in other countries, progress has been slower than expected, or in some cases halted in order to review options or to allow experience to be developed further internationally.

The conference brought together high-level representatives from government, the social sciences, repository implementation organisations, regulatory bodies and international organisations to present information and views from their perspectives as well as to discuss the interfaces of their expertise and implications of their experience. The conference was successful in gaining a shared understanding of the paths leading to geological disposal that are being followed in different countries and, based on this, in assisting national representatives in finding and refining social and political ways forward that are most appropriate to their own particular national conditions.

The conference built upon the success of similar international events held in 1999 in Denver¹ and in 2003 in Stockholm.² The sponsors of the conference were the OECD Nuclear Energy Agency (NEA), the International Atomic Energy Agency (IAEA), the European Commission (EC) and the International Association for Environmentally Safe Disposal of Radioactive Materials (EDRAM). The conference was organised and hosted in the city of Berne by the Swiss National Co-operative for the Disposal of Radioactive Waste (Nagra).

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1. US Department of Energy (2001), *Proceedings of the Conference on Geologic Repositories: Facing Common Challenges: 31 October-3 November 1999, Denver, Colorado*, USDOE, Washington, D.C.
 2. Nuclear Energy Agency (2005), *Geological Repositories: Political and Technical Progress, Workshop Proceedings, Stockholm, Sweden, 7-10 December 2003*, OECD/NEA, Paris.

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The programme as well as the contributed papers are only available in electronic form at: www.nea.fr/fsc/icgr2007.pdf.

SUMMARY OF THE CONFERENCE

Day 1: Ensuring political and institutional legitimacy

Opening addresses

The opening address was given by **Moritz Leuenberger**, Swiss Federal Minister and Head of the Department of the Environment, Transport, Energy and Communications. He drew an analogy between radioactive waste and art or, more specifically, development of geological repositories and development of a gallery such as the Zentrum Paul Klee where the conference was being held. They each represent a legacy or heritage that society seeks to preserve or protect over long times. Everyone has an interest and wants their say on such long-term social assets and projects. Progress is only possible in conditions of open dialogue involving all parties irrespective of standpoint or views. It has to be acknowledged that we cannot foresee the future, but we can imagine and consider possibilities. Having considered the problem, commitment is needed at all levels to finding acceptable solutions and taking collective responsibility for pre-existing decisions (producing the waste in the first place) and for decisions that still have to be made. Time is needed, not only from a technical point of view, but importantly to develop the necessary social understanding and acceptance – “you cannot make the grass grow faster by pulling it!” Switzerland is now at the beginning of the process of implementing the repositories it needs; the rules and guidelines for the siting process have been set out and it can now move forward with the involvement of all interested and affected parties, knowing what the objectives and conditions are for the process.

An address on behalf of the conference sponsors was given by **Luis Echávarri**, Director-General of the Nuclear Energy Agency (NEA) of the Organisation for Economic Co-operation and Development (OECD). L. Echávarri referred to the “triple curse” of radioactive waste: waste is something we are taught to reject, radioactivity is both mysterious and dangerous and it is associated with nuclear energy production. Dealing with these negative feelings goes beyond the competence of the technical specialists and the past emphasis on technical issues may even have hampered the development of social understanding and acceptance. Moving forward requires trust in the technical specialists, but also environmental, educational and energy policies that allow the technical specialists

to play their roles alongside other actors within a transparent decision-making process. At one time, disposal was viewed as a relatively short-term activity along a path to be defined at the outset. Now, the implementation of a disposal project is viewed as an incremental process, in which future generations will also be involved in making decisions. Such a project requires the long-term commitment of society and its political leaders based on environmental and energy policies that fully incorporate principles of long-term safety and sustainable development. Hence the value of a forum such as this conference where, through the exchange of information with other colleagues faced with similar tasks worldwide, decision makers and opinion leaders can become better informed of progress, current debates and plans.

Keynote addresses on strategic and policy developments

At the highest level, senior national representatives and leaders of international organisations must set the strategic goals and the framework to allow important national projects, such as the development of a nuclear waste repository, to proceed. In order to achieve practical implementation, this framework must provide processes for reaching technically sound and safe solutions that are also acceptable from social and political perspectives.

Session 1 consisted of keynote addresses by political representatives from France, the USA, Japan and Germany, by senior representatives of international organisations – the OECD/NEA, IAEA and EC – and by the chairman of the Swedish National Council for Nuclear Waste. The addresses covered views on the role of government and international organisations and practical experience in different countries with the implementation process from political, legislative and public perspectives. Some key points that were made are as follows.

Radioactive waste is the inevitable consequence of nuclear energy programmes and, independent of the future of nuclear energy and of the fuel cycle chosen, high-level waste (including spent nuclear fuel) has already been produced and requires safe and secure management. **Greg Schulte**, U.S. Ambassador and Permanent Representative to International Organisations in Vienna, remarked that new nuclear energy construction is needed to meet future energy needs, while also limiting carbon dioxide emissions. **Tomihiko Taniguchi**, Deputy Director-General, Nuclear Safety and Security, International Atomic Energy Agency (IAEA), noted that the failure to resolve the high-level waste disposal issue had left a legacy of doubt on the part of the public and politicians regarding the overall safety of the nuclear cycle. **Georg Arens** of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (Germany) stated that, in his country, the future role of nuclear energy in electricity production significantly influences the debate on radioactive waste disposal.

Geological disposal is an essential element of the management strategy for high-level radioactive waste. **Claude Birraux**, Member of the French National Assembly, First Deputy-Chairman of the Parliamentary Office for Scientific and Technological Assessment (France), **Kenji Ogiwara**, Vice-Minister, Ministry of Economy, Trade and Industry (Japan), and **Zoran Stančić**, Deputy Director-General for Research (EC), noted the importance of research in both national and international programmes. This may eventually lead to alternative or improved solutions, but no speaker challenged the claim that, for the waste from existing programmes, geological disposal offers the required long-term safety and is technically feasible now. In this light, “wait and see” is not considered an acceptable approach and is not sustainable. L. Echávarri noted that such an approach is unethical and potentially unsafe. G. Schulte noted that the sooner one country dispels the myth of “no solution” by siting, licensing and operating a high-level waste repository, the easier it will be for others to follow.

All countries that produce high-level radioactive waste have a duty to ensure its safe and secure long-term management, which is also the responsibility of national governments. K. Ogiwara described how the Japanese government has set the legal framework for implementation of the final disposal project, envisioning a volunteer process in which full regard will be paid to the wishes of municipalities and prefectures (regions), although it is considered that further publicity and encouragement is now needed to promote the project. C. Birraux described how the French Parliament has taken, and continues to take, direct responsibility for the process leading towards final management solutions through national legislation with defined objectives and decision points; he also noted that solutions need to be implemented within each country, which is a view accepted by most countries and fixed in law in several cases. T. Taniguchi, however, noted the possibility of shared nuclear cycle facilities, including repositories, which would have cost advantages for countries with small nuclear programmes. G. Arens pointed out that repository safety begins with a transparent site selection process, on which the German government’s efforts are currently focused.

Both L. Echávarri and T. Taniguchi emphasised the strong common international safety framework that is in place through the Joint Convention³ and IAEA Safety Standards, and the importance of information exchange and discussion that takes place under the terms of the Joint Convention, the CPPNM⁴ and within the fora offered by international organisations.

3. International Atomic Energy Agency (1997), *Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management*, INFCIRC/546, IAEA, Vienna.

4. International Atomic Energy Agency (1980), *Convention on the Physical Protection of Nuclear Material (CPPNM)*, INFCIRC/274 Rev. 1, IAEA, Vienna.

Panel discussion on strategic and policy experience

The panel session featured political representatives from Germany, Switzerland, Belgium and France, each with experience related to the development of radioactive waste disposal policy or projects in their own countries, regions or municipalities, plus a senior representative of the EC. The session was chaired by **Elizabeth Dowdeswell**, Special Advisor to the Board, Nuclear Waste Management Organisation (NWMO), who led the public engagement process on nuclear waste management approaches in Canada.

E. Dowdeswell identified three trends or issues that appear to be common to the debate on nuclear waste disposal across countries: the linking (or not) of the need for waste management solutions to future energy policy; the increasing trend of engaging citizens in complex policy decisions, which is a new factor for nuclear energy; and the need to reconcile the long time needed for development of nuclear waste management solutions with the relatively short timescale of political mandates. She then invited the panellists to describe how the debate on such issues had unfolded within their respective jurisdictions.

Volker Giraud, Head of the Section “Disposal and Decommissioning”, Ministry of the Environment of Baden-Württemberg (Germany), observed that, following a twenty-year long licensing phase and the exhaustion of all legal options, work has now started on converting the Konrad mine for the disposal of low-level and intermediate-level radioactive waste, commencing waste emplacement in 2013. In the case of high-level waste, however, despite more than 30 years of work it has not been possible to find a final repository site that is acceptable to all those involved. At present, the process is halted for political reasons – the German states have confirmed through resolution of the Federal Council that the Gorleben salt dome is a suitable final repository location, but the Federal Environment Ministry believes that a new search should be initiated for a final repository location. He also noted the issue of development of a repository close to national borders, which could be the case for a Swiss repository close to the German border; communication is needed between neighbours since the neighbouring country is also a stakeholder.

Ute Blohm-Hieber, Head of the Unit for Nuclear Energy, Waste Management and Transport, Directorate-General for Energy and Transport (EC), addressed four questions related to geological disposal: What has been done so far? What has been achieved? How is it communicated? What are the consequences? There have been extensive research and development and some pilot demonstration experiments. This has led to consensus on the suitability of the concept and that technical aspects are mainly solved. This, however, does not seem to have been well communicated to the public, which has consequences for

the public view of both geological disposal projects and attitudes towards new nuclear electricity production. This is illustrated by the results of the Eurobarometer surveys. U. Blohm-Hieber concluded that, while acknowledging that some technical and scientific issues remain open, technical experts must make clearer positive statements on the safety, feasibility and wealth of technical experience related to geological disposal.

Hannes Germann, Member of the Council of States (Switzerland), gave an overview of the Swiss situation and programme. The system of direct democracy in Switzerland, with national and cantonal referenda, means that the public are experienced in assessing and making decisions on controversial and difficult issues, and that technical issues have to be communicated to the public. An energy shortfall is forecast in Switzerland that will leave the country to some extent dependent on imported electric power. Partly in this light, two referenda against nuclear power generation and further build were both defeated. In the case of the proposed repository for low- and intermediate-level waste at Wellenberg, although the local community was in favour of development, the project was rejected by cantonal referendum. The responsible federal ministry has now set out a staged process for siting geological repositories in Switzerland (the so-called “sectoral plan”), which assigns highest priority to safety and suitable geological locations, but also takes account of the local environmental and infrastructure implications and related concerns of the potential host cantons and municipalities, as well as neighbouring regions.

Kris Van Dijck, Member of the Flemish Parliament and Mayor of Dessel (Belgium), outlined the process and experience with the local partnership arrangement between the municipality of Dessel and the Belgian waste management agency (ONDRAF/NIRAS) in bringing forward the project for near-surface disposal of short-lived radioactive waste. This process, which was undertaken in line with decisions of the federal government and developed by ONDRAF/NIRAS in collaboration with interested communities, has been a very positive experience. The process has been carried out with full local participation (partly in view of existing local experience in nuclear matters around the Mol-Dessel nuclear site) and with technical guidance and information from ONDRAF/NIRAS. He concluded that, when members of the public have sufficient opportunity to obtain information and can judge that there is technical honesty regarding the problems and possible solutions, then they are willing to engage and are fully capable of contributing positively to a project.

Cyrille Vincent, Directorate-General for Energy and Raw Materials at the Ministry for Ecology, Sustainable Development and Spatial Planning (France), pointed out that a common basis is needed in all national policies – they must be transparent, incorporate sound economic decisions and assumptions, have a sound

scientific and technical basis and be sustainable, particularly with regard to long-term financing. He outlined two examples of French national policies in these terms. With regard to the long-term management of radioactive waste, policy was initially defined by the law of 1991 and now by the law of 2006. Future generations must be protected from the wastes that are produced and the cost of providing protection must be contained within the costs of the activity that creates the waste, i.e. electrical power generation. The law ensures that sufficient funds are set aside and puts the government in control over major decisions to be taken in developing waste management solutions. The nuclear power companies report to the government and the process is overseen by regulatory authorities from both technical and financial perspectives.

Questions from the floor were taken and discussed by the panel. The points raised and discussed were as follows.

Since the US National Academy first recommended geological disposal, there has been a history of 50 years of research and development related to this option. There is also sufficiently extensive experience to allow it to be said that the full set of tools is available for developing, assessing and licensing a geological repository. The view was expressed that a key reason why no repository for high-level waste exists is that the volumes of waste are small and can be stored safely and economically. The power utilities are content with this position and progress will only occur when political pressure is applied to develop a repository.

It was observed that the link between geological disposal and new nuclear energy construction makes the question much more complex. The panel were asked their views on retrievability. The panel considered retrievability to be important because developments are possible; retrievability is a legal requirement in some countries.

It was noted, for example from the Belgian experience, that it may be easier to gain acceptance for siting in communities that already host nuclear facilities. However, the question is how to find a balance between a location with some local support that is “good enough” and potentially “better” sites elsewhere. This was not directly answered, but could depend on national policy or approach, for example as set out in the Swiss guidance on siting.

There is a range of possibilities for international cooperation, from sharing knowledge and experimental facilities – which has been very successful – to sharing waste management facilities, which, in the future, might include sharing a geological repository. The EC would, in principle, be supportive of a shared repository, but a host country is needed. On the other hand, most countries will have to find their own solutions to their waste management problems, which may also be prescribed by law.

The view was expressed that two ways to damage progress towards geological repositories were to try to find a best site and to talk about regional repositories, which would be counter to national approaches. A third would be to make a link to new nuclear power; this would be detrimental to the progress of geological disposal and it is essential to decouple the issues. The opposite view was also expressed: a positive move towards nuclear power could be beneficial and ease the way to development of geological repositories.

In summing up the session, E. Dowdeswell considered that there were five key messages to be derived from the discussion. There have been some successes, but also setbacks in some countries. Communication is very important – this should be positive about the technical merits, must include all parties irrespective of views and include neighbouring countries. Different modes of decision making can be observed in different countries – referenda, facilitated national debate and local partnership approaches. While technical arguments were once dominant in proposing geological disposal, the question of implementation is now being approached from the viewpoints of sustainable development, financial considerations and social acceptability. Whatever the national process, there is an absolute need for those leading the process to demonstrate integrity.

Closing remarks of day 1

Walter Steinmann, Director of the Swiss Federal Office of Energy, made closing remarks on the first day as follows.

Independent of the future of nuclear energy and of the fuel cycle chosen, high-level waste and spent fuel has been produced and requires safe and secure management. Geological disposal is an essential element of radioactive waste management. To wait and see is not an acceptable approach; it is neither ethical nor sustainable.

Nuclear waste management is a controversial issue and its associations (waste, radioactivity, nuclear power) create fear. Acceptance of disposal projects is intrinsically difficult to achieve, but public acceptance is recognised as being essential for the implementation of geological repositories (as for other large-scale projects). There is a need to involve society in the decision-making process. Many countries have a legal obligation to manage their own waste only and within their own territory

We need clear political leadership, knowledge and responsible stakeholders (government, cantons/states, communities, implementer, regulator, etc.). We need a waste management strategy and a stepwise decision-making process that ensures the involvement of society. Finally, we need a legal framework that allows implementation of both the strategy and the decision-making process.

We have to accept that implementation of geological disposal will need time – pulling the grass will not make it grow faster. Finally, sound science and high quality technology are essential to ensure safety and security and are a prerequisite for successful implementation.

Day 2: Ensuring protection, creating trust and bringing national projects forward

Implementing disposal of high-level radioactive waste in a geological repository within the political and legal framework discussed on Day 1 is a challenging prospect.

To implement repositories economically, and with due regard to social factors, the processes for decision making and the technical and social requirements to be met at each step of implementation need to be fairly established and well understood. To achieve this, multiple actors – industry, regulators and political as well as institutional representatives – will need to communicate effectively with each other and with the public. Having established the process and requirements, they will have to work together to carry projects through. Discussion of the approach is necessary, but cannot be open-ended or indefinite.

The following sessions explored the processes for decision making and implementation of geological repositories from the perspectives of societal involvement, practical implementation and regulatory supervision.

Societal aspects

Controversial scientific developments and major technical projects are valid subjects for public debate and decisions on whether and how to implement such developments or projects must take account of societal concerns and opinions. To achieve an informed public debate, it is necessary to provide information on the issues at hand, on realistic alternatives and their impacts. The siting of a geological repository in particular poses social and ethical questions – should a region hosting nuclear facilities also be expected to host final disposal facilities? Should siting be based on a volunteer process? To what extent are compensatory, economic, amenity or financial benefits legitimate? For a geological repository, the debate becomes most critical when it is focused within the community, municipality or region that may host the repository.

Claude Birraux, Member of Parliament, First Vice-Chairman of the Parliamentary Office for Scientific and Technological Assessment (France), introduced the session, which included a presentation of the framework for ethical and societal issues and examples of experience from Canada,

Switzerland and Sweden. He outlined principles for good governance – a clear definition of the framework at the national level, safety as a prerequisite, understandable information and communication, local participation and local and regional benefits. He also drew attention to ten “tips for action” given in the OECD Handbook *Citizens as Partners*.⁵ These are: 1. Take it seriously, 2. Start from a citizens’ perspective, 3. Deliver what you promise, 4. Watch timing, 5. Be creative, 6. Balance different interests, 7. Be prepared for criticism, 8. Involve your staff, 9. Develop a coherent policy, 10. Act now.

Carl-Reinhold Bråkenhielm, Swedish National Council for Nuclear Waste (KASAM), gave a presentation on the ethical ideas and choices stemming from the concept of sustainability, based on the work of ethicists and moral philosophers. He distinguished between “weak sustainability”, which can be achieved by considering the value or cost of economic assets and liabilities that are passed on the next generations, and “strong sustainability”, which asserts that natural capital cannot be reduced to monetary capital and that restraints are needed to protect ecological and environmental systems. Implementing strong sustainability, although it may be morally preferable, raises problems of ignorance, distance and extent – we do not know what future generations will want and need (ignorance); is it meaningful to speak of a moral responsibility to remote generations? (distance); how extensive are our obligations to future generations? (extent). He introduced a scale of diminishing responsibility based on alternate principles of justice that could be appropriate for considering our moral obligation over different future timescales – over very long times, to avoid harming future generations (minimal justice); over intermediate times, to satisfy future generations’ basic needs (medium justice); over shorter times, to contribute to future generations’ effort to achieve a quality of life at least equal to ours (maximal justice). Finally, he noted the idea of the rolling present. In this, the ethical imperatives could be to preserve the gains that our culture and civilisation have made for posterity, to keep our institutions and those institutions that maintain justice intact and to pass on to future generations a greater capital in the form of more knowledge and better developed technology than we ourselves received from previous generations.

Kathryn Shaver, Nuclear Waste Management Organisation (Canada), described how the NWMO sought to develop a recommended management approach collaboratively with Canadians. This was achieved through a process of engagement with citizens and specialists using a wide variety of communication and dialogue tools. From this dialogue, common ground emerged concerning values, ethical principles and objectives that are key to choosing a management

5. Nuclear Energy Agency (2001), *Citizens as Partners, OECD Handbook on Information, Consultation and Public Participation in Policy-Making*, OECD, Paris.

approach, the desire to consider a new approach, building on the strengths of other options and principles and expectations for implementation. Societal requirements for implementation were presented, including factors related to timing, future choices, adaptive technology, safety as a priority siting to meet social and ethical requirements, aboriginal rights, information and communication and preparing future generations for their responsibility. The “Adaptive Phased Management” approach that has been selected is designed to satisfy these requirements. The NWMO faces a continuing challenge and is committed to embracing adaptability guided by ongoing dialogue and new learning, providing an inclusive, collaborative decision-making process and being an open, transparent and accountable learning organisation.

Michael Aebersold, Swiss Federal Office of Energy, described the radioactive waste management policy and plans in Switzerland and, in particular, the new federal ministry sectoral plan for deep geological repository development. The plan defines a three-stage selection process based on geological suitability, regional and local implications and technical choices between sites. The underlying goals of the approach are consideration of all interests and concerns by involving the public, transparent handling of conflicts, fulfilment of expectations and creation of win-win situations. The procedure is designed to ensure fairness and transparency, joint definition of the rules, a step-by-step approach and open information. The plan defines broad consultation and foresees the early and continued involvement of society at all levels (regional, affected parties and interest groups, individuals). This participatory approach does not ensure the success of a project, but should promote its acceptance.

Jacob Spangenberg, Mayor of Östhammar, and **Kaj Nilsson**, Project Manager LKO – Competence building on nuclear waste issues in Oskarshamn municipality (Sweden), jointly presented the experience from the viewpoints of their respective municipalities. These municipalities, which already host nuclear power facilities, have both agreed to take part in pre-feasibility studies followed by site investigation and feasibility studies related to siting of the Swedish final repository for spent nuclear fuel. The working structures and methods by which the municipalities engage in the process were described. J. Spangenberg noted the key principles of their engagement: local politicians will make final decisions, municipal residents need to have confidence in the overall process and neighbouring municipalities and local NGOs must be allowed to participate. K. Nilsson noted that the process is as important as the content – it is necessary to define the actors and their roles, define participation (how and when) and realise the importance of the regulator. A local veto empowers the public and the local decision makers. He reported that local opinion polls showed that the balance of views in Oskarshamn had consistently moved in favour of the project over the period of engagement.

Implementation aspects

The nuclear industry is responsible for ensuring the safe management of the radioactive waste it produces within international safety guidelines and within the policy and regulatory framework developed by national governments. This includes the development, operation and closure of radioactive waste facilities and provision of the necessary finances. Repository developers in many countries have substantial experience in technical areas of implementation, assessment and presentation to regulators. Experience of developing and managing societal input to repository decision making is more limited. This remains an area in which repository developers are open to learn and anticipate that the development of the necessary dialogue, taking account of specific national and local characteristics, will be an ongoing challenge.

Luis Echávarri (OECD/NEA) introduced the session, noting that each of the four speakers represented a different stage in the repository development process, a different geology, a different canister design, different logistical undertakings and a different regulatory and societal context. The session was organised as a panel discussion, with short presentations from each speaker followed by discussion with the audience.

Kenneth E. Nash, International Association for Environmentally Safe Disposal of Radioactive Materials (EDRAM) and Nuclear Waste Management Organisation (NWMO, Canada), briefly mentioned EDRAM⁶ and its objectives and then went on to describe the history of the Canadian nuclear fuel waste management programme. Key lessons learned have been that it can take a long time to recover from failure in siting, that the pace of implementation must be consistent with societal pace (and societal expectations can change) and that relationship building as well as collaborative planning are needed. He identified special factors surrounding the siting of a nuclear fuel waste repository in Canada – the distinct cultural and legal status of the aboriginal people, geographical size, the extent of relationship building prior to siting, the influence of new build nuclear proposals and possible entry of Canada into GNEP.⁷ He also mentioned the positive progress with respect to the geological repository for low- and intermediate-level radioactive waste in the municipality of Kincardine.

Marie-Claude Dupuis, National Radioactive Waste Management Agency (ANDRA), outlined the implementation process for geological disposal in France. Progress along the lines mandated by the law of 1991 (investigation of alternative solutions, operation of a URL, demonstration of the feasibility of a safe repository in a clay formation allowing for reversibility (Dossier 2005),

6. EDRAM is an association of CEOs and chairmen of implementers.

7. The US Department of Energy's Global Nuclear Energy Partnership.

organisation of support to local development, etc.) enabled formulation of the new policy set out in the law of 2006. Under this law, solutions formerly seen as alternatives are considered as complementary. ANDRA is responsible for waste storage and disposal, while ANDRA and the CEA will work together on the disposal of waste from future nuclear cycles. This is included in a National Radioactive Material and Waste Management Plan in which all types of radioactive waste are considered within a consistent framework. A stepped-up timetable towards a geological repository has been established, leading to site selection, review by the authorities and a new law defining specific conditions for development of the repository (with provisions on retrievability) by 2015.

Claes Thegerström, Swedish Nuclear Fuel and Waste Management Company (SKB), outlined the implementation of the Swedish concept for deep geological disposal. The method (KBS-3) proposed in the 1970s has been progressively developed over more than 30 years through extensive R&D and assessments. The Government gave the go-ahead for site investigations in the municipalities of Oskarshamn and Östhammar in 2001-2002 and deep drilling has just been concluded. Site selection will be based primarily on safety criteria. Given comparable safety conditions, other criteria, such as environmental impact, will be used. The licence application for the final repository will be filed within a few years. Provided this satisfies the scrutiny of the regulatory authorities and reviewing bodies, a licence will be issued so that construction could start around 2012 and the first canister could be emplaced in 2020. The Swedish programme has evolved over the past 30 years with consensus between the nuclear power utilities and political interests. C. Thegerström identified three important principles behind this process: a regulated stepwise implementation process, clear division of roles⁸ and organised local consultation. In particular, the long period of dialogue with the local residents has generally led to increased trust in the implementer.

Edward F. Sproat, Office of Civilian Radioactive Waste Management (OCRWM, USA), gave an overview of U.S. nuclear waste policy and its passage towards the development of a geological repository for spent nuclear fuel and high-level waste at Yucca Mountain. The process can be traced back to the 1957 report of the US National Academy of Sciences that recommended geological disposal. Central is the Nuclear Waste Policy Act (NWPA) of 1983 that made the DOE responsible for the disposal of spent fuel and high-level waste, set up the site investigation programme and established the Nuclear Waste Fund. The 1987

8. The producers are legally responsible for the waste; SKB acts on their behalf to manage the waste and find a method and site for final disposal. The regulators review SKB's programme and ensure that it meets the requirements on safety and radiation protection.

NWPA Amendments Act mandated one site (Yucca Mountain) for characterisation, which was designated as the site for the repository in 2002. Licensing is a two-step process – construction authorisation followed by a licence to receive and possess the waste. Closure of the repository must be preceded by a period when retrievability is possible. The NWPA encourages and funds participation by affected units of governments and tribes. The best achievable schedule⁹ for Yucca Mountain envisages that the DOE will submit the licence application to the Nuclear Regulatory Commission (NRC) in June 2008 [*the application was actually submitted on 3rd June 2008*]. The NRC could then authorise repository construction in 2011, followed by construction for initial operations in 2016 and initial receipt of waste in 2017. Answering a question from the floor, E. Sproat stated that the law should soon be modified to allow an extension of the Yucca Mountain repository beyond the current limit of 70 000 metric tonnes. Alternatively, the DOE will propose to set up a second repository.

In the course of the discussion following the presentations, the speakers stressed that a high-level waste repository would be needed regardless of the evolution of the back-end of the fuel cycle (e.g. Generation IV reactors or re-introduction of reprocessing). L. Echávarri stressed that all projects presented had good chances of success and reminded the audience of the Finnish repository currently in the initial phase of construction.

Regulatory aspects

Ulrich Schmocker, Swiss Federal Nuclear Safety Inspectorate (HSK, Switzerland), introduced this session. The role of the regulators is to establish the regulatory requirements for hazardous processes and facilities in order to protect workers, members of the public and the environment. Regulatory bodies set the requirements for licensing and the procedures for meeting these requirements. They will also specify conditions for the development, operation and closure of facilities and carry out the necessary reviews, inspection or monitoring to ensure that the conditions are met. To fulfil their role, regulatory bodies must be independent of political and industry pressures, trustworthy and seen to be acting in the interests of society. Importantly, they must engage in dialogue with the developer or operator and all interested parties to ensure that, while providing sufficient protection and control of potentially dangerous activities, the regulatory requirements are also practicable and appropriate to the facility and hazards.

While all countries base their regulation of geological disposal on a common international framework, the details of its enactment may differ, e.g. due to

9. This schedule depends on timely issue of all necessary authorisations and permits, the absence of litigation-related delays and enactment of legislation proposed by the government.

different legal frameworks and distribution of regulatory responsibilities, differences in geological disposal concepts and historical differences. Discussions within international fora such as the IAEA Waste Safety Standards Committee and the OECD/NEA RWMC Regulators' Forum have enabled regulators to understand these differences and to confirm that, while differences in application exist, common principles of protection and bases for their application are maintained.

Dale Klein, Nuclear Regulatory Commission (United States), presented the role of the US NRC. While the US Environmental Protection Agency (EPA) has the legal responsibility for developing environmental and dose-based standards for the Yucca Mountain repository, the NRC will serve as an independent regulator to ensure that any repository adequately protects health and the environment. Independence does not mean working in isolation; the NRC communicates actively with the DOE, industry, the public and other stakeholders, including state, county and local governments and affected Native American tribes. D. Klein observed that promising efforts are underway in the Multinational Design Evaluation Program (MDEP) to share knowledge and experience on power plant design and to promote global convergence in associated codes, standards and regulations. He considered that this model might also be appropriate with respect to geological disposal facilities.

Jukka Laaksonen, Radiation and Nuclear Safety Authority (STUK, Finland), outlined the legal and regulatory situation and process leading to the development of the repository for spent nuclear fuel in Finland. The 1994 amendment of the Nuclear Energy Act requires permanent disposal in Finland, with no export or import of spent fuel allowed. The principles behind the Finnish solution are not to leave nuclear waste as a burden to future generations, to take care of nuclear waste using today's proven technology and to manage waste without the need for foreign support. STUK duties include preparation of nuclear safety regulations, safety evaluation (necessary for licensing), inspections to verify facility safety and compliance with licence conditions and inspections on nuclear waste management and material safeguards. Current underground investigations at Olkiluoto are expected to lead to the proponent's application for construction by 2012 and, subject to a STUK review and a government decision, application for an operating licence around 2020. J. Laaksonen identified the elements contributing to the success of the Finnish programme as being a well defined regulatory framework, clear responsibilities and political commitment; quality and transparency of the scientific and technological programme; a stepwise, open and defensible siting process; local and national trust and local socio-economic benefits.

József Rónaky, Hungarian Atomic Energy Authority (HAEA), outlined regulatory and policy aspects of radioactive waste management in his country. He

described how an attempt to license a site for near-surface disposal of L/ILW at Ófalu during the 1980s failed due to the public opposition. A new law of 1996 on atomic energy defined principles and clear responsibilities for radioactive waste management in Hungary, including the establishment of a Central Nuclear Financial Fund (CNFF). A site selection process led to the identification of the Bábaapáti site for a deep repository, with both the process and the selection being reviewed and endorsed by an IAEA expert mission. J. Rónaky identified key elements of the success of the current process as being the new legal framework, clear assignment of responsibilities (between government, regulators and operator), transparency of the licensing procedures, involvement of the public and financial support of the local municipalities. The most important change was acknowledgment of the national importance of radioactive waste management.

André-Claude Lacoste, Nuclear Safety Authority (ASN, France), outlined recent international progress on harmonising the safety requirements for a geological repository. The IAEA Safety Standards are essential for the harmonisation of safety requirements worldwide. Two important recent documents are the new Safety Fundamentals (SF-1)¹⁰ and the Safety Requirements for geological disposal (WS-R-4).¹¹ The Western European Nuclear Regulator's Association (WENRA) is developing two reports on radioactive waste and spent fuel storage and on decommissioning of nuclear installations. Updated safety reference levels were published in 2007 as working documents. The European Pilot Study was initiated by the French and Belgian safety authorities, now also joined by regulators and technical support organisations from Finland, Germany, Spain, Sweden, Switzerland and the United Kingdom, plus representatives of the IAEA and the EC. The aim is to share regulator experience and opinions on the expectations for different elements of a safety case for geological disposal. The group has produced a report on the regulatory review of a safety case for geological disposal and a report on methodologies for treating the uncertainty in the long-term safety case. The study concluded that regulatory frameworks differ between countries, but that regulatory practice differs much less. A.-C. Lacoste considers that the harmonisation of safety reference levels is desirable and will be reached for some issues related to radioactive waste under WENRA. A first step towards harmonisation of safety requirements for geological disposal is occurring in the European Pilot Study.

10. International Atomic Energy Agency (2006), *Fundamental Safety Principles*, Safety Fundamentals No. SF-1. IAEA, Vienna.

11. International Atomic Energy Agency and Nuclear Energy Agency (2006), *Geological Disposal of Radioactive Waste. Safety Requirements*. IAEA Safety Standards Series WS-R-4. IAEA, Vienna.

The way forward – Panel discussion

The final session was a panel discussion among senior representatives from parliament, a waste producer, waste management organisations, a regulatory body and a national oversight body.

The chairman, **Hans Forsström**, International Atomic Energy Agency (IAEA), introduced the session by observing that, in the past two days, information had been provided from different perspectives on where we are with respect to geological disposal and how we got there. The aim of this session was to look forward and to answer the question – how can the political, societal, regulatory and implementation aspects be reconciled to achieve a successful result? He facilitated the discussion by inviting short presentations from each of the panellists and posing key questions. The session began by discussing political and societal aspects and then implementer and regulator aspects.

Political and social aspects

Kathy Riklin is a member of the Swiss Federal Parliament and is also chair [2006-2007] of the Parliamentary Commission for Science, Education and Culture. She noted the importance of exchanging knowledge and networking as illustrated in this conference. In Switzerland, the timetable for implementing a geological repository envisages operation not before 2038 or 2045, despite Nagra having started its work on radioactive waste disposal more than 30 years ago. Time is needed, both in parliament and in wider society, to develop the understanding and the required consensus. A solution is needed irrespective of decisions on future use of nuclear power. The solution of geological disposal is considered feasible today, but retrievability is an important element that leaves alternatives open to future generations. A factor in developing understanding and consensus could be improved scientific education.

Carl-Reinhold Bråkenhielm of the Swedish National Council for Nuclear Waste (KASAM) also noted the value of such a conference in terms of what the participants can take back to their national situations. He raised the issue of public dialogue – it is very important but not easy, and can be a double-edged sword. He illustrated this by a very recent case of a newspaper article in Sweden that cast doubt on the corrosion resistance of copper (key to safety in the Swedish concept), based on views from a research institute. SKB and the regulators responded immediately, stating that the issues raised were well known and had been thoroughly researched and assessed as not being detrimental to safety. He noted that today science speaks to the public, but the public also speaks back. Scientists, regulators, etc. need to consider the nature of society and how it interprets scientific results.

H. Forsström focused on this point – we need to be open and to say things are in good shape, but the media will draw attention to “bad news”. How do we adapt ourselves to this situation?

Bruce McKirdy of the Nuclear Decommissioning Authority (NDA, United Kingdom) summarised the status of the government’s “Managing Radioactive Waste Safely” programme. Following broad consultation, the CoRWM committee recommended geological disposal as the appropriate method for long-term management. The government has accepted this and the focus of the programme is now on the approach to political and social implementation. A siting process based on principles of volunteering and partnership has been developed, particularly with the assistance of the Forum of Local Authorities (FLA). Their main concerns included the right to withdraw and the negotiation of benefits. He noted that, while the discussion was centred on the general (*i.e.* not localised) process, there was little media interest.

Hans Issler of the Swiss National Cooperative for the Disposal of Radioactive Waste (Nagra) said that, in Switzerland, public involvement is very important and has been included in defining the rules of the siting process. He also noted that public concern only becomes acute when the development occurs “in their own backyard”. He considered that the regulators have a very important role as independent experts supporting the public. Both implementer and regulator must develop the confidence and trust of the public and must also involve the public.

Manfred Thumann is vice-president of Axpo Holding AG, Switzerland, which owns and operates nuclear power plants. He noted that the media need news and that bad news is more interesting. The response should not just be to kill the sensation in bad news, but to recognise a positive opportunity. The public may not be able to follow the details of a scientific question, but they should see that we are 100% serious about following up each and every issue. Hence, the response is either yes we know about this and have resolved the issue in this way, or we do not know but will follow it up immediately and let you know. It is important to be seen even if it is sometimes negative.

H. Forsström asked at what level public involvement would be needed or most important.

Jean-Paul Minon of the Belgian Agency for Radioactive Waste and Enriched Fissile Materials (ONDRAF/NIRAS) replied that this depends on the decision. National public involvement is needed for the fundamental policy and concept decisions and local public input is requested with respect to siting and local developments. This approach was being followed in Belgium, with decisions first at the national level with all options on the table and then

implementation at the local level following a fair process. He observed that the media are neither good nor bad but are simply professionals with a job to do – to put news (and information) at the disposal of the public. Dealing with the media is also a professional skill that needs to be learned through appropriate training.

Jukka Laaksonen of STUK, the Finnish regulator, noted that it is not good to respond aggressively, but rather it is better to “train” journalists in advance. STUK has held courses for journalists to inform them of the issues involved and has gained a position as a trusted source, so that in the event of a story, these journalists ask for STUK’s view. With regard to the general situation in Finland, J. Laaksonen affirmed Finnish policy principles and views – we have no right to leave nuclear waste as a problem to future generations, wait and see is not acceptable – a solution must be implemented if nuclear power generation is to continue – and finding a solution within national borders is possible for all countries irrespective of geology. Policy makers, implementers and regulators must define the path and move forward with existing technical methods and resources. The drivers are changing – sustainable development, clean energy requirements, increased safety and economy – but the general principles and therefore the need to move forward still remain.

H. Forsström noted that this was a politically sensitive point. Do we agree on the link between future nuclear power and implementation of waste management solutions? Is a new nuclear power plant possible without a waste management solution?

M. Thumann observed that it does not matter what we think. Opinion polls clearly show that the public considers nuclear power and waste management as being connected. The public wants to see a solution for nuclear waste disposal and this is needed before committing to the next generation of nuclear plants. The public may need to see practical demonstrations as well as technical reports.

K. Riklin noted that national votes in Switzerland have been against phasing-out of nuclear power generation, but the green parties are against geological repositories, knowing that the lack of solutions for waste disposal could also freeze new nuclear development.

B. McKirdy noted that, in the United Kingdom, there are two separate consultations – one on nuclear power (recently completed) and one on managing radioactive waste. The government is of the view that, since CoRWM has recommended a solution for nuclear waste that they judge to be feasible, there *is* a solution – it is only the path for implementation that is still in question. This view on waste solutions is carried to the deliberations on nuclear power. Issues of security of supply and the need for clean energy have led the government to adopt a positive attitude to new nuclear build; this is a clear shift from a decade ago.

C.-R. Bråkenhielm favoured separation of the issues, at least at the political level. We, including the opponents, have a common objective to dispose safely of existing and committed waste. The opponents may engage in the discussion on nuclear waste if the separation can be made. J.-P. Minon agreed with this, but would turn the point around – it is irresponsible to block radioactive waste disposal on account of a lack of agreement on future energy policy.

H. Forsström asked who should separate the issues. C.-R. Bråkenhielm considered that only the politicians could do this. H. Forsström invited questions and comments from the audience.

On the issue of “to communicate or not”, it was observed that you may avoid criticism by saying nothing, but if you say nothing then someone else will say something.

On separation of new nuclear build and waste disposal, it was pointed out that you cannot separate the issues unless the opponents do. The question of new nuclear build could, however, be more urgent and important than that on nuclear waste. This was acknowledged, but we could still question the link and argue to separate the issues in order to make progress – perhaps engaging the opponents in a new dynamic. It was observed that nuclear waste was a subset of the issues surrounding new nuclear build and we must therefore handle the waste issue first.

Regulatory and implementation aspects

H. Forsström then invited the discussion to move to regulatory and implementation aspects.

Representing an organisation that produces nuclear waste, M. Thumann said that the challenge could be encapsulated in two statements – we do not need a final repository now, but we do need one urgently – both statements are justified. In Switzerland, at present, there is only a small number of canisters of high-level waste and, allowing for storage and cooling, a repository will be needed in 2040 at the earliest. This does not matter – but we need something now to justify continued nuclear electricity production. In Switzerland, a majority may be in favour of new nuclear power in the light of environmental concerns and reducing reliance on imported gas, but the case will be stronger if clear steps have been taken along the waste management path. Another important issue, as a utility, is to know what the solution looks like and therefore how much it will cost. At present, in Switzerland, the funds set aside may be larger than needed and this acts against the economics of nuclear electricity. M. Thumann considered it was the duty of the regulators to explain to the public why it is acceptable to continue to produce nuclear waste.

J-P. Minon considered that there are three main elements – the rules, the regulator and the process. The fundamental rules – what is or not, what is “safe” – are socially determined. The rules need to be decided and understood at a national social level and they need to be clear and stable. The regulator needs to be strong, experienced and trusted – if the regulator gives permission to proceed, then this should assure society that it is safe to proceed. Thus, the regulator also needs the power to say no. The process must facilitate and allow the implementer, the regulator and the public to interact effectively. A procedure is needed to ensure progress and continuity of the dialogue – to put all the issues on the table and determine key issues. Complete and open documentation of the inputs, discussions and decisions is essential.

H. Issler noted that the goals should be set at the federal level. The way forward should then be specified in a roadmap with clear milestones. This must define the decisions to be made, when and by whom and the discussion needed for the decisions. Flexibility is important – keeping options open allows adaptation to new information and conditions. It would be reasonable to set milestones on the same timescale as political mandates so that a constant political review and endorsement or modification of the process is possible. All parties – politicians, implementers and regulators – must communicate that progress has been made and continues to be made.

B. McKirdy noted positive changes in the UK framework, particularly the move towards more active and early involvement of the regulatory body in the review of implementers’ proposals. For the implementer, this reduces project risk by receiving early input on the acceptability of proposals. It also positions the regulator as an authoritative, independent source of information to other stakeholders.

J. Laaksonen commented that it is not wise to keep all options open. It is important to make a decision in principle, with one concept in mind, and then pursue that path. The Finnish programme is now in the phase of a ten-year underground research programme leading to the development of a geological repository. The research may lead to modifications of the design and implementation, but the goal is clear. The regulator has important roles – to set safety requirements (for all times in the future) and to review the implementer’s research and engineering programmes, safety analyses and cost estimates. The regulator should also explain, to the policy makers and to the public, the need to decide on a final solution for nuclear waste and the means towards it.

H. Forsström asked whether the difference in view on flexibility (cf. H. Issler and J. Laaksonen) was related to stage in the programme. H. Issler replied that the Swiss have a specific goal of 2040 for a repository, but consider

it good to keep flexibility for as long as possible within this time frame. M. Thumann commented that the important choice is where to build a repository. Nagra has established the regions in Switzerland where repositories could be safely developed, but time is needed for the public to follow the arguments and engage in the siting decision.

J. Laaksonen commented that it was a mistake to try to find the “best” place – in the Finnish case, the four sites investigated showed no differences in terms of safety and the choice was therefore between sites that already hosted a nuclear plant and also favoured repository development. K. Riklin noted that, in Switzerland, the public generally agrees a repository is needed, but as soon as a location is suggested then the local public opposes it. One option could be to decide a long time in advance.

H. Forsström invited comments from the audience.

It was observed that the Swiss have a democratic culture that demands a choice. The process being followed aims to provide a choice between at least two sites. Switzerland is also different in having a very heterogeneous geology compared to Finland.

It was observed that Germany had found a site and “dug a hole” but were not in a position to implement a repository for political reasons. Scientists would like to complete the scientific and technical work, to produce safety and feasibility results and then give this information to the decision makers. Above all, political leadership is needed to take the process forward.

H. Forsström thanked the participants and handed over to Claes Thegerström and Werner Bühlmann to present their closing conclusions.

Closing statement

The closing summary of the conference was presented jointly by Claes Thegerström of the Swedish Nuclear Fuel and Waste Management Company (SKB) and **Werner Bühlmann** of the Swiss Federal Office of Energy.

It is affirmed that there is *a common objective* to develop geological repositories. These must be based on sound science and high quality technology, provide safety, security and environmental protection and be both socially acceptable and economically feasible. They must also be developed by a transparent process within the national legal and societal framework.

The supporting conditions for this development are in place. There is a solid scientific and technical foundation – extensive R&D over more than 30 years,

demonstrations of technology in hand and planned, safety assessment and modelling capabilities available and continuing national and international collaborative programmes. There is an established international framework of safety standards, recommendations and guidance (ICRP, IAEA, etc.) and international organisations (OECD/NEA, IAEA, EC, etc.) that provide peer review at different levels, evaluation of “state of the art”, fora for exchange of information and experience and co-ordination of efforts.

It should be noted, however, that the world is continually changing – not so much in science but to some extent in technology and certainly with respect to political and social expectations. The changes may be significant over the timescale of geological repository implementation. We should be open to future changes but must plan with what we have and what we know now.

This conference has illustrated that *a variety of paths* are being followed which relate to factors such as the motive and timing for geological disposal projects, national legal framework and national decision-making processes.

The motives for implementing repositories may be to deal with wastes from past and current nuclear power programmes (a practical need to deal with the liabilities), in view also of future nuclear power generation, an ethical view including sustainability and combinations of the above.

With regard to timing of implementation, some countries have chosen to implement disposal at the soonest practicable time, while others consider that disposal will be needed eventually but is not a current priority.

An overall legal framework is required, which defines the national process, the actors, their responsibilities and roles, milestones and timescales and financial conditions. This still leaves many questions open with respect to the consultation and decision-making process: How is the process designed (e.g. adaptive approaches)? How are conclusions drawn and decisions derived? To what extent can decisions be revisited? The consultation process may include consideration and choice among all long-term waste management options, or the decision to implement geological disposal may be taken directly by government or parliament.

When considering issues and priorities for siting, the focus may be on technical aspects of site selection (geological properties, land use planning, etc.) or on societal aspects (volunteer siting, regional or local decisions, etc.). The roles of nuclear municipalities must also be considered. In most cases siting will be based on an integration of all of the above issues.

Key issues in the process of developing geological repositories include the following:

- Trust must be developed (through credibility, integrity and accountability). Methods exist for promoting and maintaining these qualities. Trust takes a long time to build, but can be quickly lost.
- Communication is very important, to all stakeholders and appropriate to each stakeholder's needs.
- Openness and flexibility enable an implementer to develop a project considering the needs of the different stakeholders and to accommodate evolving expectations of society (energy policy, environmental concerns, etc).
- Time is needed to build relationships, to develop projects and to implement them (from technical and social perspectives).
- Maintaining the process over long times can be a difficult. The process must continue through relatively short-term political changes, working in the longer-term interests of the public and affected communities.

Decisions may be prepared and made at different levels. The national process should specify which decisions are to be made, by whom and on what basis. The regulator is responsible for ensuring a sound, safe and secure project. Decisions on national policy may be made by government or parliament, through national consultation or by referendum. Regional and state governments will be involved in decisions on siting within regions. Expectations of local host communities or municipalities may be paramount to implementation at a given site. It needs to be recognised that all levels and all stakeholders may contribute to the debate or consultation, but specific decisions necessarily lie with only a few actors who bear the legal responsibility.

Different paths are possible with respect to the regulatory system and its application. The approach may be prescriptive, with tight requirements on process and safety case, or permissive, making it the responsibility of implementer to propose a satisfactory option or case. Harmonised requirements that apply to all such major developments may be important. A key question is what licences are needed, when and based on what. A separate licence or formal permission to proceed might be required at each step, or a one-step approval might be given. In any case, ongoing or periodic review and updating of the terms of a licence are likely.

In conclusion, considering the progress that has been made since the last ICGR conference in 2003, the following points can be made. The need for deep

geological disposal has been confirmed and reinforced. Steady progress is underway in many countries – programme decisions have been taken in several cases and there is additional experience of societal engagement. Difficulties exist and will continue to appear; these need to be handled. On a positive note, however, collective experience on the key elements needed for progress exists worldwide and this international experience can assist future developments in individual national programmes.

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