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Stepwise Approach to Decision Making for Long-term Radioactive Waste Management

Experience, Issues and Guiding Principles

NEA No. 4429

NUCLEAR ENERGY AGENCY
ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

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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.

FOREWORD

Radioactive waste exists as a result of both past and current practices. One of the most challenging tasks is the management of long-lived waste that must be isolated from the human environment for many thousands, or even hundreds of thousands, of years. Although significant technical progress has been made in developing management schemes that, according to technical experts, would ensure long-term safety (e.g. engineered geologic disposal), the rate of progress towards implementing such solutions has been slower than expected. The contrast between expected and observed rates may be partly attributable to an earlier technical optimism. More significant, however, are the setbacks, which have arisen mainly from an underestimation of the societal and political dimensions.

In long-term radioactive waste management, consideration is increasingly being given to concepts such as “stepwise decision making” and “adaptive staging” in which the public, and especially the local public, are to be meaningfully involved in the review and planning of developments. The key feature of these concepts is development by steps or stages that are reversible, within the limits of practicability. This is designed to provide reassurance that decisions can be reversed if experience shows them to have adverse or unwanted effects. A stepwise approach to decision making has thus come to the fore as being of value in advancing long-term radioactive waste management solutions in a societally acceptable manner. Despite its early identification within the radioactive waste management community as an important means for reaching solutions and decisions in which there is broad-based confidence, the bases for and application of stepwise decision making has not been widely reviewed. Guiding principles of any such process are still being formulated, its roots in empirical social science research have not been fully reviewed, nor the difficulties of its implementation analysed. The report reviews current developments regarding the approach to stepwise decision making in long-term radioactive waste management with the aim of pinpointing its current status, to highlight the societal dimension, to analyse its roots in social sciences and to identify potential guiding principles and issues in implementation. Many of the lessons reviewed derive from the context of siting and developing disposal facilities, but could be applicable to other management concepts.

This report is meant to help build closer ties between the radioactive waste management and the social science communities, contributing to the reflection on stepwise decision making through the provision of several perspectives supported by an extensive set of references. Overall, it is observed that there is convergence between the approach taken by the practitioners of radioactive waste management and the indications received from field studies in social research. A strong basis for dialogue across disciplines thus exists and general guiding principles can be proposed, at least as a basis for further discussion.

Acknowledgements

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SUMMARY OF KEY POINTS

The context of long-term radioactive waste management is being shaped by changes in modern society. Values such as health, environmental protection and safety are increasingly important, as are trends towards improved forms of participatory democracy that demand new forms of risk governance in dealing with hazardous activities. These changes in turn necessitate new forms of dialogue and decision-making processes that include a large number of stakeholders. The new dynamic of dialogue and decision-making process has been characterised as a shift from a more traditional "decide, announce and defend" model, focused on technical assurance, to one of "engage, interact and co-operate", for which both technical assurance and quality of the process are of comparable importance to a constructive outcome. Consequently, the scientific and engineering aspects of waste management safety are no longer of exclusive importance. Organisational ability to communicate and to adapt to the new context has emerged as a critical contributor to public confidence.

In the new decision-making context it is clear that (a) any significant decisions regarding the long-term management of radioactive waste will be accompanied by a comprehensive public review with involvement of a diverse range of stakeholders; (b) the public, and especially the local public, are not willing to commit irreversibly to technical choices on which they have insufficient understanding and control; and (c) any management options will take decades to be developed and implemented, which will involve stakeholders who have not yet been born. Thus, a "decision" no longer means opting for, in one go and for all time, a complete package solution. Instead, a decision is one step in an overall, cautious process of examining and making choices that preserve the safety and well-being of the present generation and the coming ones while not needlessly depriving the latter of their right of choice. Consideration is thus increasingly being given to the better understanding of concepts such as "stepwise decision making" and "adaptive staging" in which the public, and especially the most affected local public, are meaningfully involved in the planning process.

The key feature of a stepwise decision-making concept is a plan in which development is by steps or stages that are reversible, within the limits of

practicability. In addition to the institutional actors, the public is involved at each step and also in reviewing the consequences of previous decisions. This is designed to provide reassurance that decisions may be reversed if experience shows them to have adverse or unwanted effects. Discrete, easily overviewed steps facilitate the traceability of waste management decisions, allow feedback from regulators and the public, and promote the strengthening of public and political confidence. They also allow time to build trust in the competence of the decision makers as well as the implementers of a waste management project. A stepwise approach to decision making has long been implemented in national waste management programmes, e.g. since the early eighties in the USA and in the Scandinavian countries. However, despite the early implementation of the stepwise approach to decision making, the subject is still being developed and debated. In particular, accepted guiding principles are still being formulated, the roots of any such process in empirical social science research have not been fully reviewed, nor the difficulties of its implementation analysed. A detailed analysis might not have been possible until recently, however, before more experience was accumulated. The NEA Forum on Stakeholder Confidence has examined the above points in the present report, whose key messages are summarised hereafter.

Decisions are already being made in a stepwise and participatory fashion, and there is thrust to increase public participation in decision making

Decisions are already being taken – and progress towards radioactive waste management solutions is already being made – in a stepwise fashion. Governments and the relevant institutions are incorporating provisions that favour flexibility in decision making, such as reversibility of decisions and retrievability of waste. In addition, governments and the relevant institutions are increasingly implementing instruments of participatory democracy that will require new or enhanced forms of dialogue amongst all concerned parties. For example, partnerships are created with local communities or communities are given means to interact significantly with the decision-making process. These arrangements promote the building of trust in decision makers and implementers.

Stepwise decision making allows for reversibility of decisions

Reversibility denotes the possibility of reconsideration of one or a series of steps at various stages of a programme. Such a reversal, of course, must be the result of careful evaluation with the appropriate stakeholders. This implies a need for review of earlier decisions, as well as for the necessary means

(technical, financial, etc.) to reverse a step. Reversibility also denotes that, when practical, fallback positions may be incorporated both in the long-term waste management policy and in the actual technical programme. In the early stages of a programme for waste disposal, for instance, reversal of a decision regarding site selection or the adoption of a particular design option may be considered. At later stages during construction and operation, or following emplacement of the waste, reversal may involve the modification of one or more components of the facility or even the retrieval of waste packages for some period of time, from parts of the facility. Thus, reversibility in the implementation phase requires the application of a retrievable waste management technology.

Not all steps or decisions need be or, indeed, can be fully reversible, e.g. once implemented, the decision to excavate a shaft cannot be reversed and the shaft "un-dug". On the other hand, these decisions can be identified in the process and used as a natural hold point for programme review and confirmation. Reversibility is thus also a way to close down options in a considered manner. In the same vein, if the need to reverse course is carefully evaluated with appropriate stakeholders at each stage of development of a facility, a high level of confidence should be achieved, by the time a closure decision is to be taken, that there are no technical or social reasons for waste retrieval.

Competing requirements of technical safety and societal control are to be reconciled in long-term waste management

Due to the extremely long-lasting potential danger of radioactive waste, the primary feature that waste management facilities should demonstrate is long-term safety. At the same time, several stakeholders demand future controllability and retrievability of waste when these are placed in underground repositories. Only a step-by-step approach to technical implementation can assure that a balance between safety and controllability consideration, appropriate to a particular national or programme context may be met simultaneously, and that robust systems for waste management may be established. Such robust systems include monitoring during characterisation, operation and, in the case of final disposal, the post-operational phase. In response to the tensions between considerations of technical safety and societal control, many implementing organisations are focusing their efforts on developing a final repository from which the waste is retrievable. In some cases, retrievability for some period of time is also a legal requirement.

Public involvement and social learning processes are facilitated by a stepwise approach

There is significant convergence between the approach that is being taken by the practitioners of radioactive waste management and the indications received from field studies in social research. Empirical research studies in social science identify confidence in the radioactive waste management methods and trust in the decision making and implementing institutions as key factors of public acceptance. These studies also indicate that gaining familiarity with, and control over, radioactive waste management technologies and institutions are crucial for building up trust and confidence. Familiarity and control are to be gained through public involvement and social learning processes. Therefore, bottom-up approaches are proposed, where decision makers and other stakeholders are advised by scientific experts, but at the same time, decision makers and experts consider the objectives, needs and concerns defined by stakeholders. Bottom-up approaches are largely facilitated by stepwise procedures that provide sufficient time for developing, through deliberation, discourses that are both competent and fair.

Competing social values exist and lend complexity to decision making

Research on organisational management suggests that competing values inevitably need to be embodied in societal decision processes for these to be successful, and that the dominant values may change over time. For example, in the past, decisions related to radioactive waste management were dominated by a technical command-and-control approach, focusing primarily on finding technically optimal solutions. Later, this approach has given way to an individual-rights orientation, with a focus on participation and on reaching decisions that are both technically sound and at the same time have broader community support, even if they may not result in the solutions initially chosen by the experts as optimal. When participation and community support are accommodated, a further shift is then seen in seeking distributive equity. The tension that exists between competing values like technical efficiency, community support and distributive equity, lends complexity to decision-making processes. Research indicates that it is impossible to satisfy all the competing values by an idealised decision-making process. In a highly developed democratic society, however, all desired criteria should be accommodated at least to a degree.

Overarching principles of public involvement, social learning and adaptive decision making are emerging from practical experience and social research

A consensus appears to emerge from the experience in both social research and practical radioactive waste management. Three overarching principles are the essential elements of any decision making that seeks broad societal support, namely:

- *Decision making should be performed through visible, iterative processes, providing the flexibility to adapt to contextual changes*, e.g. by implementing a stepwise approach that provides sufficient time for developing a competent and fair discourse.
- *Social learning should be facilitated*, e.g. by promoting interactions between various stakeholders and experts.
- *Public involvement in decision-making processes should be facilitated*, e.g. by promoting constructive and high-quality communication between individuals with different knowledge, beliefs, interests, values, and worldviews.

In the radioactive waste management context, a set of specific action goals should be targeted

A set of goals specific to the radioactive waste management context may be stated as a way of translating into action the principles outlined above. In particular, in order to identify and implement solutions that are widely regarded as legitimate, it will be important:

- to have an open debate and decisions on the national policy regarding energy production and the future of nuclear energy;
- to develop a broad understanding that the status quo is unacceptable and that an important problem needs to be solved;
- to define clearly the actors and goals of the waste management programme, including the source, type and volume of waste to be handled;
- to define a safe and technically and politically acceptable combination of waste management method and site;
- to identify one or more technically and politically acceptable site(s) for a waste management facility;

- to negotiate tailor-made compensation/incentive packages and community oversight schemes with host and neighbouring communities;
- to implement decisions by fully respecting agreements.

Implementing a stepwise process raises a number of methodological issues to be resolved

Long-term solutions to manage radioactive waste will typically take decades to be implemented. Incorporating the views of national, regional and local stakeholders and allowing for the integration of their views will likely be difficult to implement in the decision-making process. In particular, progress can no longer be expected to be linear when an iterative approach is used.

The concrete arrangements for sketching out and agreeing on decision phases, for selecting and involving stakeholders in a participatory process, and for adapting institutions to meet long-term expectations, will require careful planning and adaptation to each national context. Criteria will be needed for balancing the social sustainability and the efficiency of a process made more lengthy and uncertain by added decision checkpoints. It will be important that both focus and attention are kept with time and that a guarantor of the process be properly chosen. Continued reflection and exchange on an international level can make a positive contribution to these efforts.

1. INTRODUCTION

Radioactive waste exists as a result of both past and current practices. In nuclear countries it arises mostly from the production of energy by nuclear power and, in a subset of nuclear countries, importantly from defence activities. In nuclear and non-nuclear countries radioactive waste arises from medical and research applications, as well as from industrial applications of radioactive materials. Thus, most countries possess some amounts of radioactive wastes.

One of the most challenging tasks is the management of long-lived radioactive waste that must be isolated from the human environment for many thousands, or even hundreds of thousands, of years. Similar challenges are found in the management of other wastes that are not radioactive but are also hazardous and never decay. Although significant technical progress has been made in developing management schemes that, according to the technical experts, would ensure long-term safety, e.g. engineered geologic disposal, the rate of progress towards implementing such solutions has been slower than expected. The contrast in expected and observed rates may be partly attributable to an earlier technical optimism. More significant, however, are the setbacks, which have arisen mainly from an underestimation of the societal and political dimensions (NEA, 1999a; NEA, 1999c). Reservations have been expressed by the broader public about the ability to manage radioactive wastes and the degree of hazard they pose (Eurobarometer, 1999 and 2002). Indeed, the misperception sometimes exists in the wider public that radioactive waste management involves risks that are higher than operating nuclear power plants (e.g. Charron, *et al.* 2000). Reservations expressed by part of the public may also be connected to a lack of confidence in the safety of nuclear power, and sometimes to outright opposition to nuclear power and associated organisations, or to a lack of understanding of how radioactivity generates risk, or even to a general lack of trust in scientific developments. In any event, it is understandable that there may be resistance towards committing irreversibly to actions whose consequences are not fully understood.

In this context, consideration of societal demands has been brought to the fore. The Canadian Report of the Nuclear Fuel Waste Management and Disposal Concept Environmental Assessment Panel (CEAA, 1998) provides an example. The panel examined the concept for the management and disposal of spent nuclear fuel in Canada developed over a period of 15 years by Atomic Energy of Canada Limited (AECL). The review took nine years to complete –

from establishing the Review Panel until the final report – and the verdict was that:

> "From a technical perspective, the safety of the AECL concept has, on balance, been adequately demonstrated for a conceptual stage of development, but there is still an outstanding requirement for its demonstration from a social perspective."

> "As it stands, the AECL concept for deep geological disposal has not been demonstrated to have broad public support. The concept in its current form does not have the required level of acceptability to be adopted as Canada's approach for managing nuclear fuel wastes."

As a result of the effect of sustained and increasing public questioning, attitudes amongst decision makers in the waste management field have undergone substantial change since the late 1990s, as is exemplified by the following quote (NEA, 1999a, p. 37):

> "The implementers and regulators are more willing than ever to heed the wishes of the public in so far as these do not compromise the safety of disposal facilities. One common wish is for strategies and procedures that allow long-term monitoring, with the possibility of reversibility and retrievability. A number of programmes now consider these issues explicitly."

In particular, an important shift from a mostly-technical to a combined technical and societal focus has taken place. This important shift is reiterated in the recent US National Academy of Sciences "Disposition Report" (NRC, 2001, p. 128):

> "Political leaderships of various nations have reformulated nuclear waste programs to emphasise the need for societal choice."

This same document states as a principal recommendation (NRC, 2001, pp. 5 and 42):

> "For both scientific and societal reasons, national programs should proceed in a phased or stepwise manner, supported by dialogue and analysis."

Consideration is thus increasingly being given to concepts such as "stepwise decision making" and "adaptive staging". The key feature of these concepts is a plan in which development is by steps or stages that are reversible, within the limits of practicability. In addition to the institutional actors, the

public, and especially the local public, is involved at each step and also in review of the results of decisions having taken in a previous step. This is designed to provide reassurance that decisions are made in a transparent manner and can be reversed if experience shows them to have unexpected and unacceptable adverse effects. Stepwise decision making has thus come to the fore as being important for making progress for long-term radioactive waste management in a societally acceptable manner.

About this document

Although stepwise decision making was identified relatively early on within the radioactive waste management community (NEA, 1995) as an important means for reaching solutions and decisions in which there is broad-based confidence, the subject is still being debated and developed. Accepted guiding principles of any such process are still being formulated, its roots in empirical social science research have not been fully reviewed, nor the difficulties of its implementation analysed. This paper reviews the current developments regarding stepwise decision making in radioactive waste management with the aim of pinpointing where it stands, to highlight its societal dimensions, to analyse its roots in social sciences, and to identify guiding principles and issues in implementation. The paper focuses on decision making and governance. Accordingly, no detailed consideration is provided of financial, scientific and technical aspects. Many of the lessons reviewed hereafter derive from the context of siting and development of waste disposal sites, but could be applicable to other management options. The document reviews developments and literature up to the year 2003.

As a follow on to the present introductory chapter, the next chapter reviews actual developments and implementation of stepwise decision making in the radioactive waste management world. The ensuing chapter reviews the lessons to be learnt from field studies in social research. The indications by both the practitioners and the social research world are then brought together in the fourth chapter, which identifies overarching guiding principles for stepwise decision making as well as action goals that would translate those principles in actual radioactive waste management practice. A separate chapter is then devoted to reviewing the main issues to be faced when setting up and implementing a stepwise decision-making approach. A final chapter presents the conclusions of this study.

2. DEVELOPMENTS IN THE RADIOACTIVE WASTE MANAGEMENT WORLD

The context of long-term radioactive waste management is being shaped by changes in modern society. Values such as health, environmental protection and safety are increasingly important, as are trends towards improved forms of participatory democracy that demand new forms of risk governance in dealing with hazardous activities. In this evolving context any significant decisions regarding the long-term management of radioactive waste will be accompanied by a comprehensive public review with involvement of a diverse range of stakeholders and any management options will take decades to be developed and implemented, which will involve stakeholders who have not yet been born. At the same time, the public, and especially the local public, are not willing to commit irreversibly to technical choices on which they have insufficient familiarity and understanding, and a "decision" no longer means opting for, in one go and for all time, a complete package solution. Instead, a decision is one step in an overall, cautious process of examining and making choices that preserve the safety and well-being of the present generation and the coming ones while not needlessly depriving the latter of their right of choice. Consideration is thus increasingly being given to the better understanding of concepts such as "stepwise decision making" and "adaptive staging" in which the public, and especially the most affected local public, are meaningfully involved in the planning process. Discrete, easily evaluated steps facilitate the transparency and traceability of waste management decisions, allow for feedback from stakeholders, and promote public and political confidence. This also affords institutional actors, such as regulators and implementers, multiple opportunities to demonstrate their competence and to earn trust.

Decisions are being made already in a stepwise fashion

Decisions are already being taken – and progress toward radioactive waste management solutions is already being made – in a stepwise fashion, and in some cases is built in to the regulatory framework for decision making. In some programmes, for instance, the initial decision sequences have been subsequently subdivided into smaller steps in order to accommodate for, e.g. public

involvement, new legislation (e.g. on Environmental Impact Assessment), and/or decisions by the authorities. Thus:

- In France, after reviewing the earlier, technically-driven national programme, Parliament passed the new Radioactive Waste Act of 1991. This "responsible, democratic and transparent" framework sets up three complementary research avenues, including staged research on the geological disposal option. First multiple underground research laboratories are to be established, which will serve to evaluate potential sites for a disposal facility. Then, based on the review of laboratory research results, Parliament is to designate a site for the disposal facility and/or other research avenues (Bataille, 1994).
- In Sweden, in 1992, it was decided to license a geological repository for spent fuel in two steps. The first step involves the full licensing of a small repository (containing about 10% of the waste). After an operational period of the order of a decade, the experience will be evaluated and a decision will be made whether to retrieve the waste already emplaced or to go ahead and dispose of the remainder of the spent fuel (Papp, 1998).
- In Finland, in the phase of implementing the spent fuel disposal facility, the project will be frequently reviewed by the regulator. It is noteworthy that in addition to the original programme, two new milestones have been added: one before proceeding to construction of the underground rock characterisation facility, and another in 2006 when an interim report will be published for review. These new review points have been proposed by the Finnish Radiation and Nuclear Safety Authority (STUK) and would mean strengthening the role of the regulatory authority in the programme supervision (Vira, 2001).
- In the United Kingdom, Nirex has recently been developing recommendations for a stepwise process to be applied in decisions on long-term radioactive waste management. The recommended process would include steps of research, dialogue, consultation, and choice regarding both waste management options and sites for waste management facilities (Nirex, 2002). In the same country, the Department of the Environment, Food and Rural Affairs (Defra) and the Devolved Administrations have also put in place a stepwise decision-making programme. The programme started in 2001 and will look at long-term waste management options. A decision on which option(s) to take forward will be made in 2007 (Defra and Devolved Administrations, 2001).

- In the United States, existing licensing regulations for a proposed repository at Yucca Mountain, Nevada, provide for stepwise review and decision making with respect to construction, authorisation, initial receipt of waste, and repository closure. Decisions at each step can be taken only after completion of full and fair public hearings (USNRC, 2001). Phased implementation of the repository, if a license to receive waste at Yucca Mountain is granted, is also under consideration (Williams, 2002; NRC, 2003).

Finally, in such countries as Germany, Canada, France and the United Kingdom, it can be said that the recent setbacks to the programmes are still part of the stepwise decision making as these countries have returned to a concept-setting stage of their long-term radioactive waste management programmes. These examples illustrate the fact that the progression of stepwise decision-making programmes need not be linear. In this context, Finland appears to be the only country where a decision-making framework has been set up and followed without slippage of time scales in a manner that has been satisfactory to most stakeholders for most of the time (Vira, 2001; NEA, 2002a).

A combined technical and societal focus

Stepwise testing of decisions and their consequences is already a familiar manner of moving forward in scientific or technical areas. Generally, this involves conceiving a technical project that is flexible to changes in knowledge or to technical or physical surprises (design as you go), and is based on iterative assessment of the performance of the facility in the light of new knowledge, design changes, or both (NRC, 1990). Today all radioactive waste management programmes, and especially the ones that have been redesigned, recognise and emphasise, in a form that was not seen before, the contribution of societal involvement to the quality and legitimacy of the decisions. Indeed, without societal support, a concept can hardly be adopted, as the Canadian Panel (CEAA, 1998) pointed out. In order to have progress, there is thus a recognised need (NEA, 1999a; NEA, 1999b) for:

- broad agreement in society regarding the ethical, economic, and political appropriateness of the waste management solution;
- broad-based confidence in the practicality and long-term safety of the relevant technology;
- broad-based confidence in organisational structures, legal framework, and regulatory review process for the development of the waste management facility, including agreement on development stages.

With the new focus on combined technical and societal decision making, a new set of challenges need to be addressed. These challenges concern the involvement of stakeholders, based not only on legal requirements but also through the implementation of organisational changes within the relevant institutional bodies, allowing for new forms of dialogue and interaction, and the further development of such concepts as retrievability of waste and reversibility of decisions.

Legal bases for the involvement of stakeholders

In most OECD/NEA countries there are mechanisms for involving stakeholders, and especially the local public and local authorities, in waste management development projects and, more generally, in the planning of activities that affect major social and environmental issues. For instance, in France, the Radioactive Waste act of 1991 introduced a compulsory consultation with the local authorities and the population before surface investigations for an underground laboratory for research in waste disposal could start. The Act also instituted a local information and oversight committee (CLIS) as an open and on-going forum to follow the development of the underground laboratory. Similar legal arrangements exist in several countries. More generally, member countries in the European Union are bound by the terms of Directives on Environmental Impact Assessment (EIA) (85/337/EEC as amended by 97/11/EC) and Strategic Environmental Assessment (SEA) (2001/42/EC). These Directives have a very broad scope, requiring an assessment of both direct and indirect impacts of relevant projects, plans and programmes not only on the natural environment but also on human beings, material assets and the cultural heritage. Crucially, they make specific provision for informing the public and neighbouring EU Member States. In addition, as a result of amendments required to bring all environmental legislation fully in line with the Aarhus Convention (see below), these provisions are being reinforced to ensure both earlier and more effective involvement of the public in the associated decision-making processes. Environmental impact assessment requirements have been used, particularly in Scandinavia, as an opportunity to conduct participative assessment of social impacts as well (NRC, 2001, p. 132-134; NEA, 2002a). More specific to radioactive waste management is the Resolution of the EC Committee of the Regions on Nuclear Safety and Local/Regional Democracy (98/C 251/06).[1] The above resolution prescribes

1. Resolution of the Committee of the Regions on "Nuclear Safety and Local/Regional Democracy" (98/C 251/06), Official Journal of the European Communities, 10.8.98.

transparency, public involvement, and financial support for facilitating the participation of the affected authorities in decisions related to the siting, construction, operation and decommissioning of nuclear facilities.

In North America, the latest update of the Canadian Environmental Assessment Act increases the opportunities for participation in industrial project planning by affected stakeholders, including the public. Bill C-27, *An Act Respecting the Long-Term Management of Nuclear Fuel Waste*, which became law in mid-2002, explicitly incorporates requirements to assess social impacts and concerns (Létourneau, 2002 and 2003) and represents a restart of Canadian spent fuel waste management on a new basis. In the United States there are statutory requirements on stakeholder involvement connected to the issuance of an Environmental Impact Statement both under the National Environmental Policy Act and the Nuclear Waste Policy Act. The latter applies to the disposal of high-level radioactive waste and spent nuclear fuel.[2] In addition, environmental standards and licensing criteria for disposal of high-level radioactive waste and spent fuel have been developed with extensive public participation and input (USNRC, 2002). Overall, there exists a fund of experience in performing Environmental Impact Assessments in several fields, including radioactive waste management (see for instance Leskinen, *et al.* 1991). Box 1 summarises the typical, main stakeholders' concerns that have been identified regarding the conduct of these studies (Létourneau, 2002), which apply as well for radioactive waste management. Awareness of these concerns is required, as well as preventive actions in order to deal with them.

In many countries, legislation also requires that regulatory processes are open to the public, with consultation of the public by the regulatory bodies and public hearings being held in the case of major decisions. These requirements are reinforced in certain cases by international treaties or conventions such as the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management[3] and the Espoo[4] Convention, both of which

2. See also Section 9.1 in the "Recommendation by the Secretary of Energy Regarding the Suitability of the Yucca Mountain Site for a Repository Under the Nuclear Waste Policy Act of 1982" available at www.ymp.gov/new/sar.pdf. In it, an overview is given of the stakeholder inquiries conducted by the USDOE.

3. United Nations, International Atomic Energy Agency, International Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.
www.iaea.or.at/worldatom/Documents/Legal/jointconv.shtml

4. United Nations Economic Commission for Europe (UNECE) Convention on Environmental Impact Assessment in a Transboundary Context.
www.unece.org/env/eia/welcome.html

also require provision of information to neighbouring countries. In matters affecting the environment in general, the Aarhus[5] Convention is far-reaching especially for those countries that have ratified it, enabling early access by the public to information and the associated decision-making processes. In addition, the Convention provides a very broad definition of "the public concerned" defined as "the public affected or likely to be affected by, or having an interest in, the environmental decision making". The Convention also specifies that, for the purposes of this definition, "non-governmental organisations promoting environmental protection and meeting any requirements under national law shall be deemed to have interest".

Box 1. **Concerns raised by different stakeholders in the conduct of Environmental Impact Assessment studies**[6]

Concerns raised by the public:

- Administrative difficulties with public information sessions: e.g. lack of advertising, scheduling problems, inappropriate locale, format stifling thorough debates, language of information, information which is not user-friendly;
- No, or not enough, funding for public review and intervening activities;
- Closer consultations between the government and industry;
- Information not in their preferred language;
- Perception that comments were not taken into account;
- Not enough attention paid to social concerns and on how to redress them;
- Sense of no ongoing control.

Concerns raised by industry:

- High costs for impacts assessment activities;
- Long delays;
- Lack of credibility no matter how well assessment activities were carried out;
- A lot of effort put into organising sessions with no public attendance.

Concerns raised by governments:

- Management of review panels;
- Hidden agendas of some interveners;
- Litigation on process;
- Political tensions.

5. United Nations Economic Commission for Europe (UNECE) Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters. www.unece.org/env/pp/

6. Based on Létourneau, 2002.

New forms of dialogue and stakeholder involvement

The societal environment for decision making has been changing in a significant way. In particular, technology is no longer being perceived as the bright future; those who contested the old order are now in decision-making positions; and centralised decision has ceded to a stronger involvement of local authority. Development projects in general are rejected when stakeholders have not been actively involved in creating them and developed a sense of responsibility for them. In the area of science and technology calls are heard for dialogue between the decision makers and the public. For example, in the United Kingdom a recent report prepared by the House of Lords Select Committee on Science and Technology emphasised (HoL, 2000, p. 4):

> "A meaningful response to the need for more and better dialogue between the public and science in the United Kingdom requires us to go beyond event-based initiatives like consensus conferences or citizens' juries. The United Kingdom must change existing institutional terms of reference and procedures to open them up to more substantial influence and effective inputs from diverse groups… That direct dialogue with the public should move from being an optional add-on to science-based policy making and to the activities of research organisations and learned institutions, and should become a normal and integral part of the process."

In addition to fulfilling their basic legal obligations to inform and consult stakeholders, individual institutions in OECD countries are increasingly implementing forms of participatory democracy that will require new or enhanced forms of dialogue amongst all concerned parties. In the waste management area, partnerships are being created with local communities, or local communities are given means to interact significantly with the decision-making process (veto power, community funding in order to develop their own competence, etc.). In this context, the technical side of waste management is no longer of unique importance; organisational ability to communicate and to adapt has now moved into the foreground. The obligation to engage in dialogue and to demonstrate to stakeholders that their input is taken into account raises the questions of who can take on the role of communicator, what skills and training are needed, which tools should be developed, and what organisational changes are necessary.

The new dynamics of dialogue and decision making can be characterised as a shift from the traditional "decide, announce and defend" model, for which the focus was almost exclusively on technical content, to one of "engage, interact and co-operate" for which both technical content and quality of process

are of comparable importance (Kotra, 2000). Outstanding examples may be cited in:

- Belgium, with a new approach to siting a low and intermediate-level waste facility. Key factors are the clear identification and separation of ethical and technical choices, and the pursuit of partnerships with local municipalities (NEA, 2004). A high level of trust and reliance is placed on the decisions of the participating communities. An impact on the implementer is evident as the communication department of ONDRAF/NIRAS has been planning to set up an organisation-wide "dialogue on what it means to dialogue" (Vanhove, 2000; Bergmans, 2002) in the context of the sustainability of the management of radioactive waste (ONDRAF, 2001).
- Sweden, with important stakeholder involvement in the early phases of siting a geological repository for spent nuclear fuel. The "Oskarshamn process" (Carlsson, 2000) uses the opportunity provided by EIA legislation to engage in a multi-year dialogue on feasibility among elected and non-elected representatives of the community, implementers, and regulators, the latter playing the role of "the peoples' expert" (Westerlind and Hedberg, 2000).
- The United Kingdom, where legislators, government departments and the implementer (Nirex) have all, at separate times, taken a step back from "business as usual" to publicly review radioactive waste management orientations and engage in enquiries or consultation exercises. Among these are the enquiry by the House of Lords Select Committee on Science and Technology (UK House of Lords, 1999), the Consultation Paper by UK Administrations with responsibility for radioactive waste management policy in England, Scotland, Wales and Northern Ireland (UK Administrations, 2001), and the National Consensus Conference on Radioactive Waste (UK CEED, 1999). Nirex has reviewed the consultation literature (e.g. Nirex, 2002b) and sponsored qualitative research (e.g. Future Foundation, 2002) and is working to integrate social science knowledge into organisational practice, including performance appraisals based on desired corporate values like transparency.
- Japan, where the Ministry of Economy, Trade and Industry is fostering, amongst other initiatives, a futuristic use of information communication technology to build a shared understanding amongst all stakeholders, including risk managers and citizens, of the issues at

hand concerning the disposition of high-level radioactive wastes (Keio Institute, 2002).[7]

- In France, where a local information and oversight committee (CLIS) was created by law to follow progress on the Meuse/Haute-Marne underground research laboratory. The CLIS represents the meeting place where elected officials, associations, and professional representatives gather to discuss the approach being investigated for managing high-level and long-lived radioactive waste and to question the operator of the facility and other actors on advances and results of the investigations. The Committee consists of approximately 90 members and is chaired by the Prefect of the Meuse department. Its Bureau, consisting of 20 members, meets on a monthly basis (CLIS, 2004).
- At the international level, where technical people from national organisations charged with providing or reviewing the safety case of disposal facilities for radioactive waste are actively asking themselves how to improve the presentation of safety arguments for the benefit of non-technical stakeholders (NEA, 2002b; see Appendix B).

An overview of international approaches and experience in public information, consultation, and involvement in radioactive waste management is presented in NEA (2003a).

Changes in organisational, mission and behavioural features within radioactive waste management institutions

The responsible bodies for radioactive waste management must be able to accommodate contextual changes in order to carry out the long-term projects for which they are responsible. In particular, it must be realised that involving stakeholders in the decision making means that the organisation loses part of its control over the process. A recent NEA workshop (NEA, 2000) offered views on what would characterise an organisation capable of achieving stakeholder confidence over long time periods:

- *Organisational features* include independence, clarity of role, public ownership, dedicated and sufficient funding, a non-profit status, structural learning capacity, an internal culture of "scepticism" allowing

7. The project is being developed and implemented through the Keio Research Institute at SFC. The URL site of the project is: http://rcpor1.sfc.keio.ac.jp/ An English version is being made available.

practices and beliefs to be reviewed, high levels of skill and competence in relevant areas, including stakeholder involvement, strong internal relations and cohesion, an ethical charter or code of conduct, and a general "quality consciousness";

- *Mission features* include a clear mandate and well-defined goals, a specific management plan, a well-founded and articulated identity, a good operating record. Good integration in the entire back-end of the nuclear fuel cycle may also be seen as instilling additional confidence in the stakeholders;
- *Behavioural features* include openness, transparency, honesty, consistency, willingness to be tested, freedom from arrogance, recognition of limits, commitment to a highly devoted and motivated staff, coherence with organisational goals, an active search for dialogue, an alert listening stance and caring attitude, proactive practices, emphasis on stakeholder involvement, a policy of continuous improvement, use of third-party spokespersons, and a level of commitment to the organisation's mandate that is as profound as that displayed by civil society organisations.

Setting up this type of institutions however, requires a clear policy and relevant legislative framework, as well as, often times, changes in organisational culture. At present, the role of the regulator is, perhaps, the one that is undergoing most restyling. Whilst regulators had seen their role as remaining in the background until proper licensing procedures begin, communities have been asking that the regulator act as "their" expert. The initial feedback and experience shows that active and early involvement of the regulators with stakeholders is not necessarily perceived as endangering their independence (NEA, 2000; NEA, 2002a; NEA, 2003d). In this context, examples of responsive efforts to strike an appropriate balance between neutral distance and high availability and involvement are already to be found among regulators in Sweden, Finland, the United States, and Switzerland. Implementing organizations have also been restyling, sometimes after setbacks in their programmes, e.g. Nirex after the proposal for an underground research laboratory at Sellafield was rejected (Hooper in NEA, 2000).

Retrievability of the waste

Due to the extremely long-lasting potential danger of radioactive wastes, the primary feature that waste management facilities should demonstrate is long-term safety. At the same time, several stakeholders demand also future controllability and retrievability of wastes when these are placed in underground

repositories. Research suggests that only a step-by-step approach to technical implementation can assure that the competing interests of safety and controllability may be accommodated simultaneously and that robust systems for waste management may be established (Flüeler, 2001). Such robust systems include monitoring during characterisation, operation, and – in the case of final disposal – in the post-operational phase. By building on step-by-step validations, reliability and predictability of the system are also enhanced.

The radioactive waste community is, by and large, manifesting their intention to adhere to a technical and societal stepwise decision-making process. Although the goal of such a process is defined – passive safety and closure of the facility – it is accepted that society may want to have the waste retrieved for reasons other than technical safety. Thus, many implementing organisations are focusing their efforts on developing a final repository from which the waste is *retrievable*, at least for some period of time after waste is emplaced. This is the case in France, Finland, Sweden, Switzerland, the United Kingdom and the United States, inter alia. Retrievability is often implicit in the robustness with which the system is designed. In some cases retrievability is also a legal requirement. Bringing it to the fore is, in each case, a way to second the societal wish of being able to maintain control over the waste and how it is handled.

Broad factors that might lead or contribute to a decision to retrieve waste, and weigh in favour of building provisions for retrievability, are recognised to be as follows (NEA, 2001):

- technical safety concerns that are only recognised after waste emplacement and/or changes in acceptable safety standards;
- a desire to recover resources from the repository, e.g. components of the waste itself, or the recognition or development of some new resource or amenity value at the site;
- a desire to use alternative waste treatment or disposal techniques that may be developed in the future;
- response to changes in social acceptance and perception of risk, or changed policy requirements.

There are some arguments as well against retrievability, such as the possibility that engineering provisions for waste retrieval may compromise the long-term safety of a repository (NEA, 2001). In general, however, progress in implementing retrievability is real (European Commission, 2000b) and working methods have been proposed. A recent concept allowing for an extended time for monitoring and easier retrievability is the EKRA concept proposed in Switzerland for “monitored long-term geological disposal” (Wildi, *et al.* 2000),

which includes test and pilot facilities, as well as special organisational and institutional measures. The project Entsorgungsnachweis has investigated the technical feasibility of such a concept (Nagra, 2002) and societal decision making is taking place in Switzerland on future application of the concept.

Reversibility of decisions

While technical progress remains the focus of the implementing and regulatory organisations, the long-term, wider decision-making framework under which retrievability can be implemented (i.e. the concept of reversibility) needs more attention. *Reversibility* denotes the possibility of reversing one or a series of steps at a later stage of a programme. Such a reversal, of course, must be the result of careful evaluation with the appropriate stakeholders. This implies a need for review and, if necessary, re-evaluation of earlier decisions, as well as for the necessary means (technical, financial, etc.) to reverse a step.

Reversibility denotes the fact that fallback positions are incorporated in the long-term waste management *policy,* as well as in the *actual technical programme*. Reversibility may be facilitated, for example, by adopting small steps and frequent reviews in the programme, as well as by incorporating engineering measures. In the early stages of a programme for waste disposal, reversal of a decision regarding site selection or the adoption of a particular design option may be considered. At later stages during construction and operations, or following emplacement of the waste, reversal may involve the modification of one or more components of the facility or even the retrieval of waste packages from parts of the facility. Thus, reversibility in the implementation phase requires the application of a retrievable waste management technology.

Reversibility is meant to help a facility programme respond flexibly to:

- new technical information regarding the site and design;
- new technological developments relevant to radioactive waste management;
- changes in economic, social and political conditions and acceptance; and
- changes in regulatory guidance and its interpretation or even, possibly, in basic safety standards.

Reversibility is assured by considering and incorporating fallback positions at any given step in the development programme of a waste management

facility. This contributes both to technical confidence in the ability to manage the waste safely and, also, to confidence in wider audiences that an irreversible decision is not being made. Reversibility should not be seen as a lack of confidence in ultimate safety of a waste management option, but rather as a desire to make optimum use of available options and design alternatives.

When adopting the reversibility framework in developing a waste disposal facility, it must be made clear from the outset that not all options can be kept open at all times and that the ease of retrieval diminishes as the closure of the facility approaches. Not all steps or decisions can be fully reversible, e.g. once implemented, the decision to excavate a shaft cannot be reversed and the shaft "un-dug". On the other hand, these decisions can be identified in the process and used as a natural hold point for programme review and confirmation. Reversibility is thus a way to close down options in a considered manner. In this vein, if the need to reverse course is carefully evaluated with appropriate stakeholders at each stage of development of a facility; a higher level of confidence may be achieved, by the time a closure decision is to be taken, that there are no technical or social reasons for waste retrieval.

In order to embark successfully in a logic of reversibility in waste disposal, it is important to clarify ahead of time the principles or values that should be adhered to and their relative importance to one another. The EKRA study group (Wildi, 2000) put forward the following hierarchy of values.

1. Safety of man and the environment

Safety is necessary for an individual to be able to act, take decisions and make use of his/her freedom. Safety during the whole lifetime of the waste is paramount and should be addressed from today. Assuring safety should constitute as small a burden as possible on future generations.

2. Fairness

There must be intra- and inter-generational equivalence of opportunities and protection. However, the timescales for radioactive waste management are so long that they exceed the possibilities of our society in terms of passing-on know-how and in terms of stability of political and social institutions. When considering management concepts, a distinction has to be drawn amongst time periods, namely the period that is within grasp of current society and the period during which safety cannot be assured through human presence or intervention.

3. Individual and social acceptance

At the time of construction and operation, the facility must be acceptable by the majority of the people, especially those in the siting zone. The facility should be designed in a way that it may be acceptable also to future generations. Individual and social acceptance plays a third role because by favouring, within decision making, the present or the immediate following generations, it infringes to some extent the principle of fairness across generations.[8]

A different weight given to these principles may result in different management solutions (NEA, 2003b). In any event, proponents of the above hierarchy emphasise that the affected public should be involved in key decisions on characterisation, construction, and closure. This means "technicians have to be aware of the fact that the problem of a sustainable management of radioactive waste is eminently driven by technology, but has to be solved by society" (Flüeler, 2001, p. 797).

8. Indeed, it is accepted that balancing fairly the risks, costs, and benefits across generations requires keeping to principles that are, to some extent, competing with one another (NAPA, 1997).

3. THE INDICATIONS FROM FIELD STUDIES IN SOCIAL RESEARCH

Social scientists have been amongst the first to call for heightened attention to decision-making with public involvement, e.g. in siting facilities dealing with noxious substances (Armour, 1991; English, 1992; Kunreuther, *et al*. 1992; Massam, 1993). Social scientists have also played an important role in analysing and criticising the mostly-technical focus of early decisions.[9] Accordingly, while technical committees created to judge progress in waste management programmes are still the norm, there is increasing evidence of implications of social scientists. In the UK and USA, for example, the Committee on Radioactive Waste Management and the Board of Radioactive Waste Management of the National Academy of Sciences, respectively, now include experts on social and ethical issues. In Sweden, the KASAM committee, which advises the Swedish government on progress and issues in the Swedish waste disposal programme, has a membership of both technical and social scientists. This committee has been at the forefront in investigating the ethical and social aspects of waste management and disposal ever since its inception at the end of the 1980s (KASAM, 1988).

Eventually, any decision-making process that claims to incorporate societal demands must be rooted in the social sciences. The social research results that seem most relevant for understanding the principles of stepwise decision making and how it could be implemented in a societally acceptable manner come from the two rather distinct streams of risk-perception and risk-management research. Studies in both fields provide some clues as to why public concerns about radioactive waste have played such an important role in the setbacks of many countries towards reaching a satisfactory resolution to the problem of long-term waste management (Vàri, *et al*. 1994). *Research highlights the need for public involvement in order to enhance familiarity and control and, finally, trust, and identifies taking decisions in discrete steps as a useful procedural approach.*

9. The Canadian panel mentioned in the introduction had a broad membership including social scientists.

These processes are useful and productive if it is understood and accepted that the interests of the groups and individuals participating in a dialogue are not fixed once and for all and will evolve as both knowledge and the dialogue develop.

Social learning and shared control by the public are important to diffuse the perception of risk

Many studies on risk perception document the importance of contextual variables for shaping individual risk estimations. Most notably, drawing on a series of psychometric studies, a schema was proposed to explain the public's aversion to some hazards, its indifference to others, and discrepancies between the public's reactions and experts' opinions (Slovic, *et al*. 1986). It was proposed that the general public's risk perceptions could be explained largely in terms of two characteristics or factors. The first is the *dread* factor; it is defined by whether hazards are perceived to be dreadful, uncontrollable, involuntary, catastrophic, fatal, inequitable, not easily reduced, and risky to future generations. The second is the *unknown* factor; it is defined by whether hazards are perceived as unknown to those who are exposed, unobservable, having delayed effects, and posing risks not understood by science (Slovic, *et al.* 1986).

The way that general members of the public typically think about risk is different from the way that most experts think about it. Scientists and engineers who work in the field of risk assessment normally define risk in terms of the probability of specific negative consequences: typically mortality, morbidity, or environmental damage. This technical definition of risk has little relation to the factors that the public considers when judging riskiness. Conversely, the factors that the public considers to be most important when evaluating the degree of riskiness of hazards exert little, if any, influence on expert evaluations in a professional context.

Among the general public, nuclear power and radioactive wastes are among the anthropogenic hazards that are perceived as riskiest and generate the greatest level of concern, a finding that has been replicated cross-culturally in many settings (cf. e.g. Slovic, *et al.* 2000). Psychometric studies revealed that both nuclear power and radioactive waste have been considered as unknown or unproven technologies and stimulate dread in the general public. Over the years, and since such studies were begun, the perceived risks of nuclear technology have changed profile to some extent: they are no longer judged as so strongly unknown to science and to individuals (cf. e.g. Sjöberg, *et al.* 2000). Such a trend is advanced in localities where nuclear facilities have been present for longer periods and people have become familiar with nuclear technologies

(Easterling and Kunreuther, 1995). It can be assumed that in such locations, the unknown factor of perceived riskiness has been decreased through a *social learning process* by which affected communities have become familiar with nuclear technologies or at the very least, with those who work with them daily. The most effective tool that facilitates the above learning process is *public involvement* in key decisions associated with the establishment and operation of nuclear facilities (Webler, *et al.* 1995). By enhancing control by the public, participation may decrease the dread factor as well.

While trends of relative familiarity with nuclear power generation may be observed, radioactive wastes overall continue to be viewed as very dangerous (Eurobarometer, 2002, p. 23) and confidence in the technical or the political ability to manage them may be seen as very low (Eurobarometer, 1999, p. 50). *In such a context, mechanisms to ensure public involvement may be all the more necessary and valuable to establishing broad-based confidence.*

Social learning and a shared control by the public are facilitated by a stepwise approach

Risk management research suggests that not only do many lay people believe that levels of risk, especially environmental risks, are high and increasing, they also believe that these risks are not being adequately managed or equitably distributed. For example, in a study on hazardous waste facility siting, Kasperson (1986) concluded that public concerns about risk are based largely on *distrust* of the institutions responsible for risk management. Such distrust stems from perceived past failures of these institutions, and perceived *inequities* in the distribution of risks and benefits among affected parties. In her case studies on radioactive waste management, English (1992) also observed the presence of the trio of distrust, perceived riskiness, and perceived inequity, although she argued that concern with equity was a result, not a cause of, lack of trust and perception of significant risk.

Several studies indicate that the concept of trust implies that something is being risked in expectation of gain (Golembiewski and McConkie, 1975; Baird and St-Amand, 1995). The TRUSTNET programme defined social trust as “a relationship between individuals within an existing or emerging group. It takes place in situations where individuals depend on people they trust to achieve important projects entailing significant risks for them” (European Commission, 2000a, p. 27). Limiting the potential for negative impacts can reduce the degree of trust that is needed in such situations. Alongside controlling the physical factors that could produce unwanted consequences, process components can be designed to limit the reliance on trust.

These include:

1. involving in the decisions those who are affected, so that they gain more control (see Box 2); and/or
2. dividing major decisions into smaller steps, providing feedback after each step and allowing the affected people to halt the procedure if they lose trust in the "trustees".

Box 2. **Bottom-up approaches as a means for rebuilding social trust**

In their studies on the attitude of the US public toward nuclear facilities Rosa and Clark (1999, p. 39) observe extremely negative attitudes and attribute them primarily to the history of nuclear power, the high level of secrecy surrounding nuclear issues, the dominance of top-down decision making, and the continuous decline in public trust toward almost all social institutions. To rebuild trust they propose a shift to *bottom-up approaches*, with strong public involvement in assessing the costs, risks, and benefits of different options.

Various models for the bottom-up approach have been suggested and tested. A remarkable example is the "analytic-deliberative" framework developed by the National Research Council (NRC) of the National Academy of Sciences. The components of this framework are defined as follows: "Analysis uses rigorous, replicable methods, evaluated under the agreed protocols of expert community such as those of disciplines in the natural, social, or decision sciences, as well as mathematics, logic, and law to arrive at answers to factual questions. Deliberation is any formal or informal process for communication and collective consideration of issues" (NRC, 1996, pp. 3-4). In this model, analysis and deliberation are not only complementary, but also strongly interrelated: "Deliberation frames analysis and analysis informs deliberation" (p. 20). One of the most important features of the above model is that it does not restrict social learning processes to the lay public, but interprets them in a more symmetrical way, as *mutual learning.*[10]

Recent studies have identified several core elements of trust. For example, Metlay (1999) found two key dimensions of trust in institutions: an affective component (which integrates characteristics such as openness, reliability, integrity, credibility, fairness and caring) and institutional competence. In a study investigating public views on different waste management information sources, Petts (1998) found four main dimensions of trust including openness, objectivity, caring, and competence. Her research also revealed that the dimensions of trust may vary between risk issues, or between groups and individuals around the same issue, and this has significant implications for the

10. The so-called pragmatistic approach analysed in the next section is another example of a bottom-up model.

risk management process. For example, focusing on means to improve competence may not be sufficient to deal with mistrust based on a perception that regulators do not defend public interests. In order to increase trust, first the significance of the various dimensions for the various stakeholders needs to be understood. *In any case, building trust is not a fast, but rather a slow, stepwise, incremental process* (Fairholm, 1994; Slovic, 1999).

In sum, empirical research studies underline the significance of confidence in the waste management concept and programme, as well as trust in the decision-making and implementing institutions, as key factors of public acceptance. Studies also indicate that gaining familiarity with and control over radioactive waste management technologies and institutions are crucial for building up trust and confidence. *Familiarity and control are to be gained through public involvement and social learning processes*. These processes are largely facilitated by a stepwise approach which provides sufficient time for developing, through deliberation, discourse that is both competent and fair[11] (Webler, 1995).

There exist competing social values and principles, which lends complexity to decision making

Research suggests that competing social values inevitably need to be embodied in radioactive waste management processes and approaches for these to be successful, and that the dominant values may change over time. Siting methods, for instance, in the past have been dominated by a technical *command-and-control* approach, focusing principally on finding technically optimal solutions. The study of ten siting cases indicates that over time, this technical approach has given way to an *individual-rights* orientation, with a focus on participation and on reaching decisions that have community support, even if they are not optimally efficient decisions. When participation and individual rights are accommodated in the siting process, a further shift is then seen to seeking *distributive equity,* i.e. focusing on the fair distribution of benefits and burdens (Vàri, *et al*. 1994).

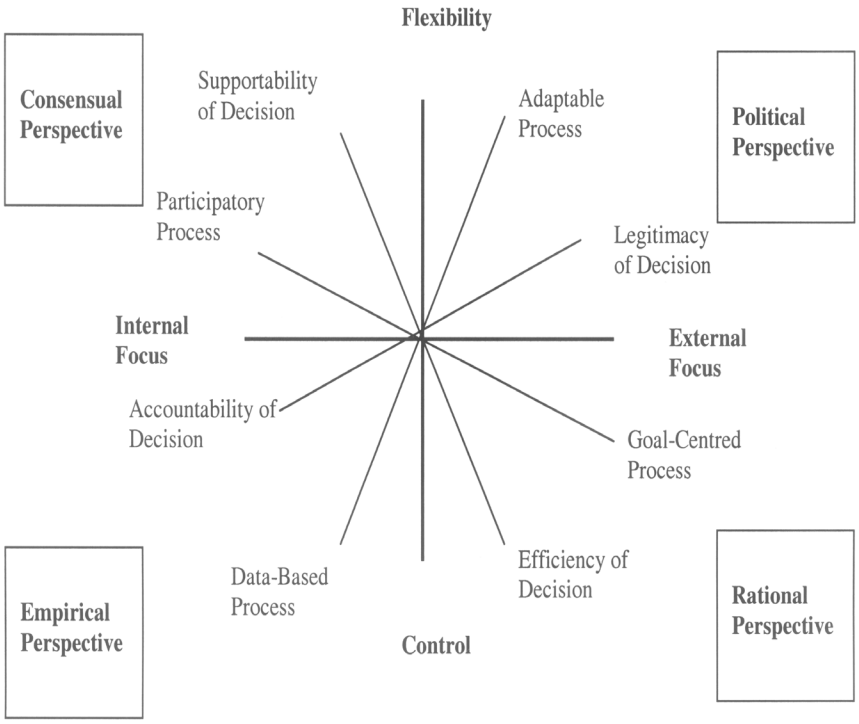
11. Based on Habermas (1971), Webler (1995, p. 58) defines competence in discourse as the "construction of the most valid understandings and agreements possible given what is reasonably knowable at the time", while conditions for fairness include that anyone who feels potentially affected must have an equal opportunity to attend the discourse, assert validity claims, challenge other participants' validity claims, and influence the decision on how to decide when there is no consensus.

There are also competing principles of fair distribution of social burdens and benefits that can be applied to siting decisions (Young, 1994). The principle of *parity* requires that all parties be treated in some sense equally. In the case of waste management, this may mean that all communities within a nation or federation get equal shares of the burden. This sharing out may be implemented in various manners. A second distributive principle is *proportionality,* which means that the burden is distributed in proportion to certain fairness criteria (e.g. responsibility for the burden; existing resources or vulnerability of the host community; etc.). A third principle is *priority* where the burden, for example the waste, is allocated in whole to one community based on selected criteria.

There is, further, a general agreement in the literature that *there is no single morally correct way for allocating scarce resources or burdens.* According to Hisschemoller and Midden (1989), what people consider "just" or "unjust" largely depends on the political system of which they are part. Views on fairness may be defined by the plural "worldviews", or cultural belief patterns that exist alongside each other in social settings (Linnerooth-Bayer and Fitzgerald, 1996). In addition, dominant views on fairness may vary over time within the same community.

The tension that exists between competing social values and principles is not limited only to the *outcomes* of the decisions (e.g. the distribution of benefits and burdens, community support), but concerns also the decision-making *processes* themselves. A conceptual framework that helps to clarify trade-offs inherent in decision-making processes is the Competing Values approach to organisational analysis (Quinn and Rohrbaugh, 1983). As shown in Figure 1 and further explained in Appendix, the Competing Values Theory defines eight evaluation criteria for decision-making process and outcome (data-based process, accountable decision; participatory process, supportable decision; adaptable process, legitimate decision; and goal centred process, efficient decision) that are, to some extent, contradictory to one another. According to the theory, *it is impossible to satisfy simultaneously all the desirable, competing values of an idealised decision process.* In a highly developed democratic society, however, desired criteria should be accommodated at least to a degree, which lends complexity to the decision-making process in radioactive waste management. This is also the source of calls for prudence in providing universal counsel on the basis of decisions that are in fact the product of national values and contexts that might be changing at a different pace in different national and local situations.

Figure 1. **Framework for competing values theory**
(Adapted from Quinn & Rohrbaugh, 1983)



Which management approach for balancing out the main different perspectives and values?

Given the requirements of public involvement and social learning that were identified before, which management approach is likely to be adequate? Drawing on the work of Habermas (1971), Wene and Espejo (1999) identified and compared three basic approaches to the formulation of policies of wide social significance. In the so-called *technocratic model*, priority is given to scientific analysis and decisions are based primarily on data provided by experts. The politician's role is restricted to intervening in situations where rationalisation has not been successfully accomplished.

At the other extreme, the so-called *decisionistic model* recognises that scientific analysis alone cannot legitimise decisions. In this model, initiative is

given to politicians, while experts are strongly separated from practical decision making and their role in the process is restricted to providing data in situations where politicians are challenged. This model attempts to separate facts from values, by assuming that science is value-free.

Finally, in the so-called *pragmatistic model* "the strict separation between the function of the expert and the politician is replaced by their critical interaction" and "reciprocal communication seems possible and necessary, through which scientific experts advise the decision makers, and politicians consult scientists in accordance with practical needs" (Habermas, 1971, p. 80, quoted by Wene and Espejo, 1999, p. 410). In this model, experts provide data on alternative solutions, on their technical characteristics and constraints but, for evaluating the various solutions, decision makers must consider objectives, needs, and concerns defined by politicians and other stakeholders.

Each of the above-mentioned models has its advantages and disadvantages. An analysis based on the competing value theory (Figure 1) of the three specific policy-making approaches[12] suggests that the *technocratic model* puts heavy emphasis on the empirical perspective. When applying this model, decision processes are likely to be largely data-based and result in highly accountable decisions. However, other perspectives are under-emphasised, which limits adaptability and legitimacy, participation and supportability, as well as goal-centeredness and efficiency.

The *decisionistic model* puts heavy emphasis on the political perspective while under-emphasising the empirical, consensual, and rational perspectives. Processes which follow this approach will respond to context and may enjoy perceived legitimacy linked to the status of the decision maker. These processes are less likely to be data-based, participatory, and goal-centred, and ultimately will be less likely to result in accountable, supportable, or efficient decisions.

By involving experts, politicians, and stakeholders, the *pragmatistic model* has a good chance of balancing the empirical, political, and consensual perspectives. As Wene and Espejo (1999, p. 410) point out, "critical and mutual interactions between experts, politicians and stakeholders are prerequisites for efficient, legitimate and authentic decisions". One of the major roles of the dialogue – and a source of confidence and legitimacy – is to bring to the fore the

12. The Competing Values Theory was originally developed for evaluating intra-organisational processes. On the other hand, Habermas (1971) focussed on social discourses and policies that typically involve multiple organisations operating at multiple levels of decision making.

often unformulated, implicit assumptions and values of all partners in the dialogue.

Progress may be more easily made if typical phases are identified with the attending, necessary degree of representation by politicians and stakeholders: information, consultation, negotiation of changes in procedures or technical details, decisions under the different missions that these stakeholders have, etc.

4. GENERAL PRINCIPLES AND SPECIFIC ACTION GOALS

Overarching principles

A consensus appears to emerge from the experience in both social research and practical radioactive waste management as reviewed above. Three overarching principles, independent of the radioactive waste management context, are the essential elements of any decision making seeking broad societal support:

- *Decision making should be performed through visible, iterative processes, providing the flexibility to adapt to contextual changes*, e.g. by implementing a stepwise approach that provides sufficient time for developing a competent and fair discourse.
- *Social learning should be facilitated*, e.g. by promoting interactions between various stakeholders and experts.
- *Public involvement in decision-making processes should be facilitated*, e.g. by promoting constructive and high-quality communication between individuals with different knowledge, beliefs, interests, values, and worldviews.

The aims are to ensure or augment:

- Familiarity and control by the stakeholders.
- Trust and confidence in the institutional actors.
- Legitimacy and supportability of the decisions.

Specific action goals for radioactive waste management

As a way of translating into action the principles outlined above, a set of goals specific to the radioactive waste management context may be stated, as reported in Box 4. They are not formal steps or milestones but ingredients that may help programmes achieve those principles.

Box 4. **A set of action goals**[13] **for radioactive waste management**

1. To have an open debate on the national policy regarding energy production and the future of nuclear energy.
2. To develop a broad understanding that the status quo is unacceptable and an important problem needs to be solved.
3. To define clearly the actors and goals of the waste management programme, including the source, type, and volume of waste to be handled.
4. To define a safe and technically and politically acceptable combination of waste management method and site.
5. To identify one or more technically and politically acceptable site(s) for a waste management facility.
6. To negotiate tailor-made compensation/incentive packages and community oversight schemes with host and neighbouring communities.
7. To implement decisions by fully respecting agreements.

These action goals propound a shared understanding and broad agreement on:

- the *system of national energy production* (Action goal 1), which is responsible for overall decisions on the use of nuclear power;
- the s*ystem of radioactive waste management* (Action goals 2, 3, and 4), which is responsible for defining the directions to be followed, programmes to be implemented, and methods to be applied for the management of various types of waste;
- the *system of waste management facility siting* (Action goals 5 and 6) which is responsible for identifying a site, as well as compensation/incentive packages and oversight schemes for host communities; and
- the *system of waste management facility implementation* (Action goal 7), which is responsible for implementing agreements on facility construction, operation, monitoring, and potential closure.

13. Inspiration for these action goals is drawn from a series of studies investigating successes and failures associated with radioactive waste management facility siting processes in various countries (Vàri, *et al.* 1994; Easterling and Kunreuther, 1995), the experiences of the radioactive waste management community (NEA, 2000; 2002a; 2003c), and the reviews provided earlier in this paper.

Articulating decisions in these four domains offers the possibility to match tasks with stakeholder capabilities and to integrate higher-order and lower-order constraints and results.

These action goals need not be pursued sequentially, but may be sought in parallel. Indeed, some of the action goals are not totally independent of one another, and it can be argued that there is value in having an integrated approach whereby a few of these goals are actively pursued simultaneously in accordance with national specificity.

The concepts underlying these goals are reviewed individually in the following sections. It is observed that these action goals have wider application than to facility siting alone and also that, *the implementation of each of these goals is largely facilitated by a stepwise approach that provides sufficient time for involved stakeholders to develop a competent and fair discourse.* To this effect, the responsibilities for organising the dialogue and the decision-making process go beyond technical institutional actors, such as regulators and implementers, and are taken up as well by policy makers and politicians.

Further, it may be observed that there are important parallels between the implementation of these action goals and the undertaking of strategic, social and environmental impact assessments as they are variously required in OECD member countries (see earlier section in this paper). Action goals 3-4, and possibly action goal 1, correspond to an SEA process at the national level. Action goals 5-7 relate more to an EIA process. To the extent that these processes are – or may become – mandatory for radioactive waste management projects, then it will be logical to ensure that any stepwise decision-making process utilises existing frameworks.[14]

(i) Openly debating the national policy regarding energy production and the future of nuclear energy

Case histories of several siting processes suggest that when radioactive waste management is part of a broader, widely accepted nuclear energy policy framework, siting decisions are more likely to be supported by the public (Vàri, *et al.* 1994). In any event the public does make a link between the waste issue

14. Sharing the assessment framework for all environmentally controversial projects has clear advantages. Namely, it avoids setting any one project apart from other projects of an equally controversial nature, and, in the perspective of sustainable development, enables a more objective and ready comparison of impacts amongst alternatives.

and the acceptability of nuclear energy as shown, for instance, by recent Eurobarometer results (Eurobarometer, 2002). In that survey, the public in the EU overall are in favour of keeping the nuclear power option open "if all the waste is managed safely". By the same token, within the public, others may fear that by demonstrating a permanent solution to the radioactive waste problem the nuclear power industry will be invigorated (Easterling and Kunreuther, 1995; Kowalski, 2002). The impression "in many people's minds that the technologies of nuclear waste management and nuclear weaponry are inseparable" is also reported (Rydell, 1989), suggesting that links between nuclear energy and military policy may also be of concern to the public.

A detailed analysis has revealed that it is not so much the current status of the debate regarding nuclear energy that affects outcomes, as it is the stakeholders' perception that they are able to participate meaningfully in decision making about fundamental questions of overall policy (Vàri, *et al.* 1994). In such a context, mechanisms to ensure public involvement may be all the more necessary and valuable to establishing broad-based confidence. In particular, the debate should address the real concerns of the stakeholders. These concerns may lie in the deep structure of conflict over new technologies, which is characterised by the fear of unknown risks, unease, and moral resistance to the kind of implied relationship with nature, as well as political protest against the power of industry to pursue strategies of technological innovation and, implicitly, social change (Schreiber, 2002; Jacq, 2003).

As part of the policy debate, it would be important to discuss the needed financial provisions to deal with the issues of sustainability and long-term liabilities. It is a confidence argument to observe that the institutional and financial arrangements are in place to take care of the costs of decommissioning and waste management based on the principle that the user pays. The recent promulgation of Bill C-27 in Canada provides an example of starting a spent fuel management programme coupled with the start up of a financing scheme (Létourneau, 2003). This Bill was heavily influenced, in its formulation, by the extensive reviews – including by stakeholders – that the earlier programme had received (Brown, 2003; Seaborn, 2003). In any event if transparency, by industry and government, and stakeholder involvement in policy making regarding the future of nuclear energy are ensured, prospects for agreement on radioactive waste management issues are better, even if debates on nuclear energy have not been fully settled.

(ii) Developing a broad understanding that changes to the status quo need to be considered and that an important problem needs to be solved

Radioactive waste exists as a result of past practices and it arises from former commitments, e.g. to nuclear power or nuclear defence programmes. From a logical point of view, it can be argued that decisions on long-term radioactive waste management need not be connected to decisions regarding the future of those commitments, but need to be focused on solving an existing problem. Indeed, in Finland, the year-2001 societal decision of further developing the Olkiluoto site for a spent fuel repository was limited to the spent fuel inventory to which that country had already committed itself (NEA, 2002a). A debate and resolution on a new nuclear power plant and the management of the attending waste took place a year later. Likewise, chances for a successful siting process appear to be improved if it is widely understood that there is a true societal need for the facility, not just a corporate desire or legislative mandate (Williams and Massa, 1983; Morell, 1984). A number of studies have also verified that, in successful siting processes, the public shared the view that the status quo was unacceptable (Kunreuther, *et al.* 1992).

There exist a variety of reasons why the existing radioactive waste management programmes may become problematic or the need for new facilities emerge. For example, existing repositories or storage facilities may need to be closed for the lack of capacity, safety reasons, or operational problems. In other cases, the waste had earlier been exported, but this was or will be stopped for technical, economic, political, or legal reasons. In the case of long-lived waste that is adequately conditioned and stored, geologic disposal may be proposed on grounds that it behoves the current generation to identify and implement a permanent solution that would result in the least possible burden on future ones while not unnecessarily depriving them of the right to intervene later. For these wastes a centralised facility for interim storage lasting a century or more may also be proposed. This is, for instance, the adopted strategy in the Netherlands for both radioactive and non-radioactive hazardous waste in order to keep all the waste in one, controllable place and see if, one day, these wastes can be recycled (Netherlands, 2002).

What is broad understanding and what is broad enough? This inevitably brings up the question of the level of consent that is needed in order to proceed with the decisions. In an issue as controversial as radioactive waste, it seems that there will always be dissension irrespective of the extent of public consultation. Consequently, much more emphasis should be placed on listening to people and valuing different opinions, in order to create proper dialogues between the various parties. Decisions about which procedures to be used for handling divergent views (e.g. voting, negotiating, involving third parties,

postponing), should be made before disputes arise. Fairness requires that such decisions be made through a participatory procedure as well.

The aim of public consultation and involvement is thus not necessarily to gain a full level of consent but rather, to create diverse dialogues among different views for the use of decision making. In any case, a broad-based, fair and competent deliberative process is needed to form a decision stating that changes to the status quo need to be considered and that an important problem needs to be solved.

(iii) Defining the actors and goals of the waste management programme, including the source, type, and volume of waste to be handled

Studies on radioactive waste management concluded that successfully siting a facility critically depends on clarity about the purpose and direction of the overall waste management policy (Kemp, 1989; Vàri, *et al.* 1994). These should be clear definition and role of the actors that will participate in implementing the programme (Summary in NEA, 2000). The role and commitment of regulators should be visible from early on (NEA, 2003d).

Chances of success are enhanced if the source, type, and amount of waste to be dealt with are well-defined and, in the case of siting, if there are guarantees that no additional types and amounts of waste from additional sources will be shipped to the facility (Kemp, 1992). These conditions were verified to exist in the recent, successful siting of the Olkiluoto facility in Finland (Vàri, 2002). They are also clearly spelled out as pre-conditions in the recent decision by the municipality of Oskarshamn in Sweden to allow the industry to investigate a site for spent fuel disposal in the territory of the commune (Oskarshamn, 2002).

In some cases, the characteristics of the waste stream are not defined before a candidate site is selected, but only during negotiations with the host community. This was the case, for example, in Hungary when a spent fuel storage facility was planned to be established near to the Paks nuclear power plant. In general, chances of local approval are higher if the implementer describes to the public the characteristics of the waste stream before asking candidate communities to accept a facility for managing it.

(iv) Defining a safe and technically and politically acceptable combination of waste management method and site

Since the long-term safety depends on how the chosen management method performs in a particular environment, the purpose of facility siting is to find an appropriate combination of waste management method and site. There are three basic approaches to seeking such a combination: site selection can precede the selection of a waste management method (site-first approach), selection of a preferred method can precede site selection (method-first approach), and method and site selection can be conducted in parallel (parallel approach).

On the basis of international experience it can be concluded that, of the three above approaches, the method-first approach seems the most successful (Vàri, *et al.* 1994). The key advantage of this approach is that the developer can present to the safety authority and the public the physical characteristics of the facility before asking communities to host it. The site-first and parallel approaches are problematic to this effect, because the public cannot be informed about characteristics of the facility and other important descriptive details until the later stages of the siting process. Also, the public in the siting region is unlikely to support a method that the developers cannot clearly describe and defend. On the other hand, because a management method must adapt to the properties of the site, the method-first approach is better suited to a situation where it is known that different sites will have similar properties. This is the case of Finland and Sweden, where the point was made that disposal sites for spent fuel would not differ significantly over the Finnoscandian shield.

There are also disadvantages to the method-first approach. If a method is selected early in the process and is not widely supported by the public, opposition may emerge later on. In particular, people may want to have more information than is actually available or reasonable at an early stage of development given that a waste management method must adapt to some extent to the site properties.

Therefore, it can be recommended that the developers first select waste management methods each one applicable to broad siting characteristics and obtain preliminary consent by the safety authorities and then remain open to modifications by taking preferences of potential host communities into consideration in concert with additional requirements by the safety authorities. Details of the waste management method, including safety standards, monitoring and mitigation measures, should be finalised after deliberations with the host community. This way, refinement of the proposed method is an iterative, stepwise process itself. A similar approach has been followed in

Finland when planning for the spent fuel facility, which resulted in the addition of the requirement of retrievability in the waste management method (NEA, 2002a) and additional steps in the decision-making process (Vira, 2001).

(v) Identifying one or more technically and politically acceptable sites for the waste management facility

There are two basic approaches to site selection processes (Nirex, 2002). The first type of process starts with identifying volunteer communities who are willing to participate in a site investigation process, and then examines technical suitability of the area (acceptance-first approach). The second type of process starts with the selection of technically suitable areas and then starts negotiating acceptance with potential host communities (technical-first approach). In both cases, the site selection process is aimed at finding a site that is both technically and politically acceptable.

The main disadvantage of the acceptance-first approach is that due to the lack of detailed information about the waste management method and the possible compensation/incentives at the beginning of the process, the number of volunteer communities is likely to be small. Subsequent technical screening or withdrawal of some volunteers for political reasons may further narrow the field. This happened, for example, in Canada during the siting of the historic low level waste disposal facility (McCauley, 2003) and in France during the search for a second underground research laboratory site in the year 2000 (Barthe and Mays, 2001). The technical-first approach has better chances to start out with a larger number of alternative sites; this, however, does not pre-determine chances for finding political acceptance.

The ideal site selection process is a stepwise process that combines dialogue fostering a wide understanding of the safety requirements and management methods with procedures for excluding sites that do not meet licensing criteria, and procedures for identifying sites[15] where residents are willing to accept the facility. A voluntary process, in which communities are allowed to withdraw from consideration at any time, usually improves the chances for community willingness to participate and for a sustainable outcome.

It is a matter of fact that nuclear host communities – where the waste is stored already in a semi-permanent way or where waste is being produced, are the most interested in having a permanent, safe solution brought to bear

15. Ideally, there are multiple communities that are willing to accept the facility, and a competitive site-selection process is employed.

(Easterling and Kunreuther, 1995). They have also a level of familiarity with the nuclear industry, knowledge of the dangers and control of radioactivity, as well as an interest for continued partnership with industry and government with a view to long-term community development. It is clear that a dialogue can develop quicker with these communities than with non-nuclear communities, and experience world-wide shows that it is with nuclear host communities that progress in facility siting has been made quickest. In Belgium, and for the case of low-level waste, there is a clear directive from government for the national waste management agency "to limit its investigations to the four already existing nuclear zones" although preliminary field studies may also be undertaken in other interested local towns or villages (Vanhove, 2000, p. 135). In Sweden, the Aka committee suggested a path to the government whereby nuclear waste management facilities would be sited close to the nuclear plants at Oskarshamn and Forsmark. Interestingly, even if SKB, the Swedish waste management agency, took a broader approach to siting, the results of siting so far – both for low-level and high-level waste and for a centralised interim store of spent fuel – are concentrated in nuclear communities as evoked by Aka in 1976 (Aka, 1976; Lidskog and Sundquist, 2004).

(vi) Negotiating tailor-made compensation/incentive packages and community oversight schemes with host and neighbouring communities

"Compensation" is defined as repayment for any necessary expenditures or losses associated with the siting and operating of the facility. An "incentive" is more than reimbursement and is a benefit to motivate local communities to accept a facility. Compensation and incentives may be financial or non-financial and can be provided at one time only or on a continuous basis during the siting, construction, or operation of the facility.

Research indicates (Armour, 1991; Easterling and Kunreuther, 1995) that compensation and incentives do not ensure public support unless the public feels that the facility is safe and there is sufficient monitoring and public control over its development and operation. Sometimes, non-financial incentives, including community oversight schemes, may promote public acceptance more strongly than financial incentives. Indeed, oversight schemes, which may include local information committees and experts independent from the industry, are seen now to be pre-requisites for the acceptance of a project, and most waste management programmes have local oversight commitments. For instance, in accepting site investigations on its territory, the Oskarshamn municipality, Sweden, stated that safety and radiation protection are not areas that are reserved only for the national authorities and the industry experts and that reports should be received by the municipality, which has also instituted

oversight schemes (Oskarshamn, 2002). In the same vein, the Meuse Department in France allowed site investigations on its territory provided that residents be widely informed as to the progress of research and that an independent council of experts be associated with the analysis of this information (Meuse, 1994).

There are various approaches to providing compensation and incentives. In cases where the balance of anticipated positive and negative impacts of a facility appears to be positive, no compensation is seen necessary (some minor incentives may still be provided). This is the case, for example in Finland, where the Olkiluoto facility is expected to give a major boost to the local economy by providing tax revenues, jobs and infrastructure. If the balance of anticipated positive and negative impacts is seen as negative, host communities are usually offered compensation, incentives, or a combination of the two.

Under the compensation-only approach, it is extremely difficult to identify and quantify all the economic, social, health, and environmental impacts of a facility. Limiting compensation to quantifiable expenses may increase the accountability of the decision, but results in less flexible and supportable processes. In case of the incentives-only or compensation-and-incentives approaches, where benefits are negotiated with the host communities, flexible and supportable processes are more likely. However, the latter approaches are sometimes criticised as buying local acceptance and equivalent to bribery. Some argue too that they may result in unfairly placing the burden of hazardous facilities on the less powerful, poor communities in which economic benefits are sorely needed. This critique does not normally apply to communities hosting one or more nuclear power facilities, such as power plants, for, in general, their current economic situation is positive, although they may rely upon continued economic partnership with the industry in case the plant is shut down and decommissioned.

When making decisions on compensation and/or incentive packages (including community oversight schemes), it is crucial that hosting the facility should be seen as a win/win arrangement by the host community and ideally by the neighbouring communities as well. This goal can be achieved only if the host community and the neighbouring communities are directly involved in negotiations regarding compensation, incentives, and community oversight schemes, and the benefit package is tailored to the concerns and needs of those affected. Drawing too narrow a circle around the proposed facility, when identifying “affected” communities, may produce conflict (Kotra, 2003). This may result in a site supported by the immediate host community, but not by more distant communities that, while impacted, receive lesser levels of compensation or benefit, which may be judged inadequate vis-à-vis the level of

inconvenience that a facility generates. Indeed, it is not unusual that the immediate host community supports a site, but the more distant communities under the same regional government do not (Easterling and Kunreuther, 1995). An example is the Wellenberg repository project, which was found acceptable by the local municipality that would host the facility, but whose rejection by the other municipalities in the same Canton contributed to the demise of the project (Nidwalden, 2002). Similarly, in Korea, although seven communities had accepted to enter the site selection process, the relevant regional governments turned down these petitions (Song, 2002). It is thus important to take into account the whole territory that is impacted (or sees itself to be impacted) by the facility.

(vii) Implementing the decisions by fully respecting agreements

The discussion above highlights how pursuing each action goal can contribute to the quality of the decisions taken. The implementation of decisions must reflect the same high degree of quality. Both the form and the intention of the decision must be respected. Failure to honour decisions destroys the credibility of the foregoing process, and can result in the withdrawal of stakeholders who previously were active partners, or can disrupt their confidence in future steps of the process.

Confirmation of the need to respect decisions is seen in the case of the Port Hope Agreement. This binding legal document was signed in March 2002 by the Canadian Federal Government with three local communities and stipulates the manner in which clean-up and management of historical radioactive wastes from uranium milling will be carried out. The elected officers of the townships were active in negotiating the agreement and, for them, it reflects community requirements. The formal agreement constitutes the basis of their confidence in the ensuing steps of the decision process, including the environmental assessment for proposed facilities. They made it clear that if the agreement is not respected in every point, they would feel justified to withdraw (NEA, 2003c), in which case the effective management of the wastes, under Federal responsibility, would be jeopardised.

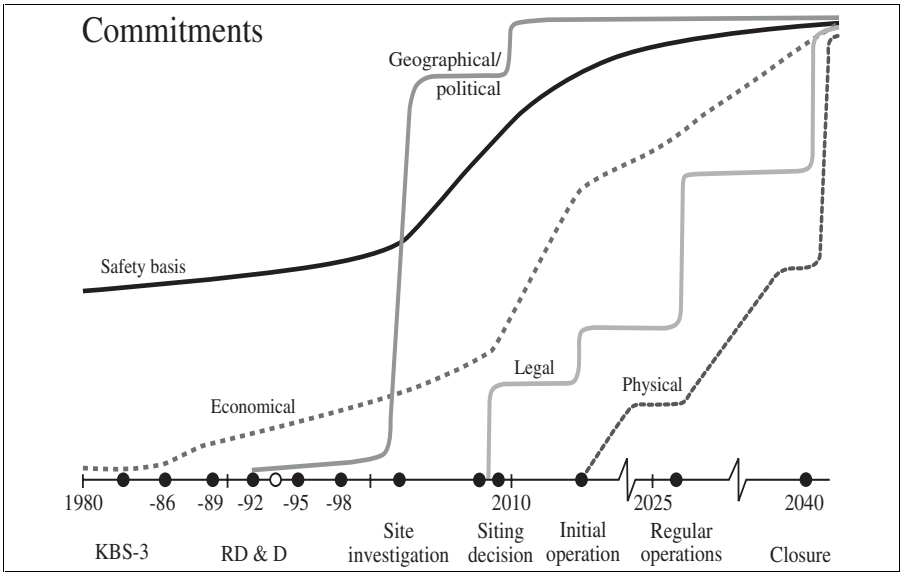
In cases where a decision fails to be implemented, the damage to the overall process extends beyond the given decision point. Society may demand that the process be set all the way back to the first point at which a wrong turning was taken. This was the experience in the case of Gorleben (Appel, 2002).

When both the letter and the spirit of decisions are respected, credibility and confidence are accrued. This was the experience of SKB, the Swedish waste management agency. Their withdrawal from two Northern municipalities when local referenda rejected the continuation of feasibility studies, although not required by any ruling, contributed to confidence and the establishment of working relations with other municipalities (Thegerström and Engström, 1999).

5. IMPLEMENTATION ISSUES

In radioactive waste management, the stepwise process of decision making will involve a multitude of actors/stakeholders and a multitude of stages spread over a long time period. Figure 2 is a qualitative representation of the various fields of activities involved in the disposal of spent fuel, showing how decisions may fall over a 60-year lapse in Sweden and assuming that the process works relatively smoothly (no showstopper or detour) (Papp, 2001). It is immediately apparent that the times scales are relatively large, and that there are several fields of activities involved as well as several types of commitments by different stakeholders – local versus national, born versus unborn, etc. – that are very unevenly distributed over time. Indeed not all stakeholders need to be involved equally at all times. It can also be seen that the first phase of the programme leading to site investigation has lasted 20 years already.

Figure 2. **A qualitative representation of the various activities involved in waste disposal, showing how the impact of activities and decisions may fall over a 60-year time lapse in Sweden assuming no showstopper and a no detour** (Papp, 2001)



Institutional factors

At the beginning of the decision-making sequence, a number of methodological issues or tasks need to be addressed, including but not restricted to the following:

- identification of relevant stakeholders;
- establishment of the potential decision sequences;
- establishment of stakeholder interaction;
- definition of a transparent decision process;
- ensuring stability of the platform/institutions involved;
- ensuring continual adaptation to changing technological, social, and political environments;
- achieving consensus on the appropriateness of the stepwise procedure.

These tasks presuppose the identification and strong commitment of institutional actors from the very start. Most importantly, an actor, preferably a public body is needed that helps the decision-making process keep focus. Such has been the role of the Ministry of Trade and Industry in Finland over the last 20 years; and such is the role that has been played by Canada's Natural Resources Ministry over the same amount of time. In other countries, other institutional bodies play a similar stimulating role: the Congress of the Unites States of America performs yearly reviews of the national high-level waste programme; the national Government in Sweden reviews the national programme every three years. Oversight bodies typically assist these institutions.

A further important actor is the organisation responsible for site selection for a specific radioactive waste management facility, facility design, construction, operation, public education, and compensation. These responsibilities may be assigned to a semi-private, private or governmental organisation, while the role of technical regulator is assigned invariably to a separate public-sector organisation. The role of the regulators as the expert in the service of the public has been especially highlighted in recent times, for example in Finland (NEA, 2002a; NEA, 2003d).

Finally, important roles are to be played in decision making regarding site selection, design, construction, operation and compensation by affected local governments. The role of local liaison groups facilitating public education and consultation has also proved significant. Local governments have been acting as

decision-making bodies by possessing a veto-power in recent site selection processes in Finland, Sweden and Canada, while local liaison groups have been instrumental in Finland, France, and Sweden.

In order to organise the dialogue(s), it may be useful to fit decision makers and other stakeholders into the four-level system identified earlier: the *system of national energy production;* the *system of radioactive waste management;* the *system of waste management facility siting*; and the *system of waste management facility implementation*. The key advantage of such subdivision in four levels is that it offers a way to organise and handle the complexity produced by the interactions between stakeholders, politicians, and experts. In particular, following Wene and Espejo (1999), discourse at each level may be matched to the knowledge and the information processing capabilities of, and the language and concepts used by, stakeholders involved at that level. Another advantage of this subdivision is that it permits integration across levels. Namely, the results of operations at a higher level define the constraints at lower levels. A third advantage is that long-term organisational stability is required only at the higher levels; changes in lower-level organisations do not threaten process integrity.

Design of stages

Contradictions between sustainability and efficiency exist when decisions are to be made about the magnitude and timing of steps in a stepwise procedure. In general, the smaller the individual steps, the better the chances for social acceptability. Since society is a complex system with many unknown relationships among its components, it can be assumed that in the case of smaller steps, the number of affected components as well as the magnitude of effects will be smaller, and thus the chance for unpredictable and uncontrollable responses will be reduced. It is also important that sufficient time be allowed after each step so that the system can respond to the intervention and its consequences can be identified. For instance, some key decisions, on waste treatment and packaging, are likely to be taken at an early stage in the process. Important questions then arise as to how reversible these decisions might be if it emerges, at a later stage, that they constrain choices and flexibility for future long-term waste management facility development, and as to how all relevant stakeholders might feasibly be involved in these early steps. Time may thus need to be built into the stepwise process to allow reflection on previous decisions to ensure that they are still valid.

With an increase in the number of steps and the intervals between them, however, duration and costs of the process will also be increasing. Therefore,

when designing a stepwise process, trade-offs between social sustainability of the process and efficiency should be considered. For instance, extending a siting process (say, doubling it from 10 to 20 years) by increasing the number of decision steps may not be so burdensome when compared to a 60 year operating and a 300 year institutional control period. At the same time, it must be clear that smaller steps are not a maneuver to make unpopular decisions pass but are taken to make better and more legitimate decisions.

Whilst the implementation of each of the above action goals is expected to be facilitated by a stepwise approach that provides sufficient time for developing a competent and fair discourse, the progress of decisions should not be expected to be linear, as possible changes in the technical, social or political background may result in the reversal or modification of former decisions. History proves that this has been the case already in radioactive waste management in several countries.

For example, utilities that had originally exported spent fuel had to reconsider their policy and provide for the management of spent fuel themselves.[16] Municipalities that initially had rejected the idea of hosting radioactive waste management facilities overturned these decisions later.[17] In some cases, programmes relying on an acceptance-first approach for site selection were forced to switch to other procedures.[18] In other cases,

16. For example, this has been the case in Finland and Hungary which had been returning spent fuel to the former Soviet Union until the early 1990s (NEA, 2002; Vàri, 1999).

17. This happened, for example, in Eurajoki (Finland), the host community for a planned spent fuel disposal facility, and Paks (Hungary), which currently hosts a spent fuel storage facility (NEA, 2002a; Vàri, 1999).

18. This happened, for example, in France, where in order to find candidate sites for an underground research laboratory a volunteer (acceptance-first) approach was used from 1993 to 1998. This process resulted in three candidate sites. The outcome of the feasibility study phase was just one licensed lab site, whereas at least two sites were required by the law. While technical features had led to the rejection of one site, the second candidate had to be eliminated in the absence of a sustainable political consensus (Barthe and Mays, 2001). This experience led government in 1999 to switch back to a technical-first approach; insufficient support to the civil servants charged with add-on stakeholder consultation after the technical pre-selection, however, resulted in the dramatic failure of this search (Mays, in press).

implementers were pressured to change the waste management method, or redefine the type of the waste stream that had been identified earlier.[19]

Besides, if they are to be genuinely deliberative, decision-making processes must be open to different outcomes as well as allow time in order to better integrate social norms and informed societal input. It is, thus, clear that legitimacy cannot be established once and for all but, over time, it will be questioned and revisited. Even social attitudes toward nuclear energy may change, and this may exert major influence on overall policies concerning the management of radioactive waste.[20]

Methodologies for stakeholder involvement: No single method may attain a perfect score[21]

Evaluation of new methods of public involvement should take into consideration both the added qualitative value that public deliberation may bring to a decision and the potential for increased democratic legitimacy of decisions (Renn, *et al*. 1995; Rowe and Frewer, 2000). Along these lines, Rowe and Frewer (2000) divide their evaluation criteria into *process criteria*, which are related to the effective construction and implementation of a procedure and *acceptance criteria*, which are related to the potential public acceptance of a procedure.

19. Examples for these developments include the siting of the spent fuel disposal facility in Finland where the concept of retrievability was adopted in a later stage of the process, and the siting of the spent fuel storage facility in Hungary, where the source and type of radioactive material to be stored at the facility was specified during negotiations with the host municipality (NEA, 2002a; Vàri, 1999).

20. The importance of policy flexibility is underlined by the changes in public opinion regarding nuclear issues. In most countries, opposition to nuclear power grew in the 1970s and 1980s, as a result of the Three Mile Island and Chernobyl accidents. In the 1990s this trend turned around in some countries, mainly due to the failure to replace nuclear energy by renewable energy sources and increasing concerns about CO_2 emissions (Löfstedt, 2001). For example, in 1990, 40 percent of the Swedish public supported the closure of nuclear power plants by the 2010 phase-out target date, while in 1999, only 16% of the population was in favor of the closure and 40% wanted to use nuclear power as long as it remained economically viable (Löfstedt, 2001).

21. This section is taken, basically verbatim, from (NEA, 2002c).

Process criteria include:

- *Resource accessibility:* public participants should have access to the appropriate resources to enable them to successfully fulfil their brief.
- *Task definition:* the nature and scope of the task should be clearly defined.
- *Structured decision making:* the participation exercise should use/provide appropriate mechanisms for structuring and displaying the decision-making process.
- *Cost-effectiveness:* the procedure should in some sense be cost-effective.

Acceptance criteria include:

- *Representativeness:* the public participants should comprise a broadly representative sample of the population of the affected public.
- *Independence:* the participation process should be conducted in an independent, unbiased way.
- *Early involvement:* the public should be involved as early as possible in the process as soon as value judgements become salient.
- *Influence:* the output of the procedure should have a genuine impact on policy.

Generally speaking, if methods of public involvement were measured against these criteria it becomes evident that no single method can attain a perfect "score". For instance, those methods that score high on the "representative" criterion, e.g. public opinion polls, standing panels and multiple focus groups, tend to score lower on the process criteria (excepting cost-effectiveness). There is often a trade-off to be made between the deliberative dimension some methods offer and the representative capacity of others, which deliberative opinion polling tries to remedy rather expensively. This point is significant, in that it underlines the fact that no one method of public involvement may be viewed as a panacea. Methods should be employed with a clear purpose in mind, and invariably a number of different methods may be utilised as part of one decision-making procedure. Evaluating an organisation's decision-making processes in the light of the above criteria is an important area of current research.

6. CONCLUSIONS

Long-term solutions for managing radioactive waste will typically take decades to implement. Stepwise decision making may well be the only feasible means for making key planning and implementation decisions. Such a process preserves flexibility, does not commit the relevant stakeholders irreversibly to a choice and allows for social learning over time. Governments and the radioactive waste management institutions are incorporating provisions that favour flexibility in decision making, such as reversibility of decisions and retrievability of the waste. Discrete, easily overviewed steps facilitate the traceability of decisions, allow feedback from regulators and the public, and promote the strengthening of public and political confidence. They also allow for the building of trust in the competence of decision makers as well as the implementers of a waste management project. Elements of stepwise decision making have been incorporated into programmes with or without legal obligation. This is in part due to earlier setbacks that have arisen mainly from an underestimation of the societal and political dimensions of decision making in the field of radioactive waste management.

Overall, there is significant convergence between the approach that is being taken by the practitioners of radioactive waste management and the indications received from field studies in social research. Empirical research studies in social science identify confidence in the radioactive waste management methods and trust in the decision making and implementing institutions as key factors of public acceptance. These studies also indicate that gaining familiarity with, and control over, radioactive waste management technologies and institutions are crucial for building up trust and confidence. Familiarity and control are gained through *public involvement* and *social learning* processes, which require time and are largely facilitated by a stepwise approach that assures development of a competent and fair discourse and allows adaptation to societal changes. Any decision on waste management method and approach is thus, by and large, a societal endeavour.

The universality of the desire for participation in the decisions – and the necessity of having a broad base to the decision – encourage the formulation of some general principles and recommendations based on both practical

experience in radioactive waste management and social sciences research. Namely: *public involvement* in decision-making processes should be facilitated, by promoting interactions between various stakeholders and experts; *social learning* should be facilitated by promoting constructive and high-quality communication between individuals with different knowledge, beliefs, interests, values, and worldviews; decision making should be *iterative* and should provide for adaptation to contextual changes. A set of goals specific to the radioactive waste management context may be identified that offer means to translate these principles into action.

A long-term process of decision making incorporating the views of national, regional, and local stakeholders and allowing for the integration of views of stakeholders will very likely be a difficult process to implement. It will be important that focus and attention are kept with time. Some of the outstanding issues have been identified. In particular, progress can no longer be expected to be linear when an iterative approach is used (this will pose challenges to traditional organisational structures and legal frameworks); criteria will be needed for balancing the social sustainability and the efficiency of a process made more lengthy and uncertain by added decision checkpoints; the concrete arrangements for sketching out and agreeing on decision phases, for selecting and involving stakeholders in a participative process, and for adapting institutions to meet long-term requirements, will require careful reflection and tuning in each national context; a democratic society must seek to accommodate conflicting values and fairness principles. Institutions and governments are aware of these challenges and examples have been given of a proactive stance, e.g. the re-styling of the role of the regulators and the search for, and implementation of, new forms of dialogue. The focus of the report is on governance and decision making. Financial and scientific and technical issues, which are typically associated with specific stepwise decision-making processes, have been addressed only in passing.

Continued monitoring of stepwise experience will provide important guidance. Continued reflection and exchange on an international level themselves can make a positive contribution to improving societal confidence in radioactive waste management decisions. Radioactive waste management is more then finding a technical answer to a technical problem. As shown in this paper, a strong basis for dialogue across technical and humanistic disciplines exists already.

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Appendix

COMPETING VALUES THEORY: BASIC PRINCIPLES

In the Competing Values Theory two basic value dimensions combine to define perspectives on effective decision-making processes. (Figure 1, on p. 37) The first value dimension is related to the structure of the process; an emphasis on *flexibility* competes with an emphasis on *control*. The second value dimension is related to the focus of the process; an emphasis on the desires of individual stakeholders *(internal focus*) competes with an emphasis on the needs of the larger collective *(external focus)*. The relative emphasis on these competing values defines four distinct perspectives on effective decision making: the empirical, the consensual, the political, and the rational perspective.

A third key consideration in evaluating decision processes is whether emphasis is placed on process (means) or outcomes (ends). Within each perspective, processes and outcomes are linked. For example, in the consensual perspective, an emphasis on participatory processes is linked with a concern for supportable decisions. Combining the four perspectives with the distinction between means and ends results in the eight criteria describing decision processes, as indicated in Figure 1 (Quinn and Rohrbaugh, 1983). Each perspective and criterion is discussed briefly below:

- The rational perspective (high control, external focus) emphasises goals and objectives. A process is *goal-centered* to the degree it focuses resolutely on the primary problem. Goal-centered processes help to reach *efficient* decisions, where efficiency is positively related to the degree to which the goals have been achieved, and negatively related to the resources required to achieve these goals.[22] Managerial activities connected with this perspective include goal-clarification, rational analysis, and action taking.

22. The rational perspective has been central to the "scientific management" school (Taylor, 1947). This school developed a management approach aimed primarily at rationalising work and making it as efficient as possible by using tools developed by ergonomics, physiology and engineering.

- The empirical perspective (high control, internal focus) emphasises data and information. A process is *data-based* to the degree to which verifiable information and formalised decision rules are used. Data-based processes help to reach *accountable* decisions, where accountability means that decisions are clear, well-documented, and can readily be justified.[23] Related managerial activities include defining responsibilities, measurement, documentation, and record keeping.

- The consensual perspective (high flexibility, internal focus) emphasises participation. In a *participatory* process, opinions of all key stakeholders are considered in each phase of the decisions and have considerable influence on the outcomes. Participatory processes help to reach *supportable* decisions, where supportability is related to the degree of acceptance by key stakeholders.[24] Related managerial activities include facilitation of participation, conflict resolution, and consensus building.

- The political perspective (high flexibility, external focus) emphasises adaptation and creativity in approaches to a problem. A decision process is *adaptable* if, in response to unexpected events and interventions by the larger collective, it can be easily changed. Adaptable processes help to reach *legitimate* decisions, where legitimacy means acceptance by a broader public, even under changing political circumstances.[25] Related managerial activities include political adaptation, creative problem solving, and the management of change.

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23. The empirical perspective has been central to the "internal process" school, which developed a managerial approach aimed primarily at stabilising organisations by using rules, traditions, and hierarchical structures (Fayol, 1949; Weber, 1947).

24. The consensual perspective has been central to the "human relation" school of management which shifted attention from the mechanical and technical aspects of work to social-psychological and ethical considerations (McGregor, 1960; Argyris, 1964).

25. The political perspective has been central to the "open systems" school which shifted emphasis from organisational stability to continual adaptation and innovation (Mintzberg, 1975).

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